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International Research on Food Security, Natural Resource Management and Rural Development

Development on the margin

Book of abstracts

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Preface

The annual Conference on Tropical and Subtropical Agricultural and Natural Resource Management (TROPENTAG) is jointly organised by the universities of Bonn, Göttingen, Hohenheim, Kassel-Witzenhausen, Hamburg, ETH Zurich as well as by the Council for Tropical and Subtropical Research (ATSAF e.V.) in co-operation with the GIZ Advisory Service on Agricultural Research for Development (BEAF). The TROPENTAG has become the most important international conference on development-oriented research in the fields of food security, natural resource management and rural development in central Europe. Since 1999, it provides an international platform for scientific and personal exchange for students, junior and senior scientists, development experts and funding organisations together with their various international partner institutions. The increasing international interest in the TROPENTAG of a large and still growing audience demonstrates its importance on the agenda of both, the development-oriented scientific community and implementing development organisations. Some 1100 participants from 82 countries have registered for the 2011 conference in Bonn.

The lead theme of the 2011 conference is “Development on the margin”. We consider this topic of particular relevance as main-stream development focuses primarily on high-input intensification strategies that often neglect or are inappropriate for fragile and remote areas, for the low-input systems, and for many indigenous communities, considered to be “on the margin”.

With growing demographic growth, globalisation effects and a weak resource base in most developing countries, the supply with agricultural commodities must be achieved not only efficiently but also in a way adapted to the diverse social-ecological systems. The ever-growing need for agricultural production and productivity needs to be reconciled with the growing concerns for the environment but also with equality and a just access to resources for the different interest groups.

What is the future role of the marginal environments with fragile balances in natural and cultural ecosystems? How to balance development in favourable and marginal environments? And how or to what extent can (or should) marginalised people and communities become key players in an increasingly globalised resource use? These questions are addressed at the Tropentag 2011 through 120 oral presentations,

12 guided poster sessions with about 375 posters and a number of thematic side-events.

The contributions and discussions focus in particular on the following areas:

- Vulnerable people (Food security; Markets and consumption; Livelihood strategies; Social systems and rural services);
- Resource use and ecosystem services ((Agro)Forestry; Biodiversity; Soil fertility; Water management);
- Production systems on the margin (Crop and animal production systems; Product quality)
- Systems under stress (Land degradation; Climate change effects; Biotic and abiotic stresses);
- Resilience and vulnerability (Use or protection; Favourable or marginal environments; Collapse or re-organisation).

We hope that the scientific contributions in this book will help you to find answers to the important research and development questions related to these topics and the "Development on the margin" theme.

Our very special thanks go to the colleagues from Berlin, Braunschweig, Bonn, Göttingen, Halle, Hanover, Hohenheim, Kassel-Witzenhausen, Potsdam and Zurich who acted as reviewers for the submitted contributions and thus contributed substantially to enhance the scientific standard of the conference. We like to express our gratitude to Eric Tielkes, DITSL Witzenhausen, who handled the registration, the book of abstracts and many more issues. Our thanks include all our donors whose financial contributions have made this conference possible.

We wish you an enjoyable and rewarding conference.

The organising committee
of the TROPENTAG 2011

Mathias Becker
Christine Kreye
Christina Ripken

Bonn, September 2011

Message

The *Tropentag* (Conference on Tropical and Subtropical Agricultural and Natural Resource Management) is a firmly established event in the agricultural research arena. It is an important international forum for the exchange of information, experience and knowledge among international development experts and researchers from a broad range of scientific institutions and disciplines. And, not least, the *Tropentag* provides an excellent opportunity for young scientists to network and establish contacts that help them become involved in international agricultural research. So it was my pleasure to accept the role of patron for this event. Successful development policy greatly depends on the education and science sector's dedication to innovation and on progress in that sector.

The challenge of fighting hunger in the world continues to be urgent, and indeed it has rarely been more pressing than today. In this connection, great hopes are being placed, not least, in agricultural research. The research sector will only be able to fulfill these expectations if it attracts the best and the brightest. A growing world population must be fed, and the limited natural production base must be preserved. At the same time, climate change will alter the conditions for agricultural production, and in many places it will alter them for the worse. Demand patterns, too, will change – especially in developing countries and emerging economies. All this requires productive and resilient plant varieties and livestock, intelligent forms of plant protection, veterinary medicine and water management, and improved forms of forest management. What is needed is sustainable production systems as well as strategies that ensure that our world's poor, hungry and malnourished people have access to food.

The Federal Ministry for Economic Cooperation and Development is currently providing some 20 million euros per year for international agricultural research. It is one of the biggest donors in this field. This support for international agricultural research is an integral part of our strategy for rural development, which has finally been given a central role again in Germany's development policy and which is our contribution to creating long-term, sustainable food security.

"Development on the Margin" is more than just the theme of this year's *Tropentag*. It is the guiding principle for the type of agricultural research that will be needed in future, because we will only be successful if we manage to include hungry, poor and marginalised people in development. To that end, we will need to embark on

new avenues – not least in the field of agricultural research. Development-oriented agricultural research focuses on people in developing countries and on their needs. The scientists are working on the ground – in touch with the problems as well as the opportunities. They are working as part of a closely-knit network of agricultural research institutes, universities, and other research and development institutions. The *Tropentag* is a powerful illustration of the diversity and the close global network of agricultural research.

I wish all *Tropentag* participants an exciting and fruitful conference.

Dirk Niebel
Federal Minister for Economic Cooperation and Development

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Plenary speeches

The Doubly Green Revolution

SIR GORDON CONWAY

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About a billion people in the world are chronically hungry. They live at the margin of our society, without enough food to live normal productive lives. A high proportion is of women and children. More than 130 million of children under five years of age are underweight, that is they are well below the standard weight for their age. This represents nearly a quarter of the under fives in the developing countries.

The numbers increase each time there is a food price spike and we face the daunting prospect of feeding a growing population over the next 40 years, in the face of deteriorating land and water resources and the damaging effects of climate change.

We have the science and technology that can help us produce more food, but we need much more than this. There are no magic bullets. People on the margin have limited access to resources, to technologies, to markets and to sources of income. We need a new Doubly Green Revolution that is not only productive, but stable, resilient and equitable. Everyone must benefit. If we do not act more and more people will become hungry.

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Marginal People - “Surplus Youth” in the Global Taxonomy of Insidious Harm

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Marginality does not exist. No creature is marginal to its own existence. But among humans marginality is everywhere. The paradox arises because the concept does not refer to a real state or condition. It is the product of taxonomy. Humans are classifying animals. Society and economy function through erecting taxonomic schemes to legitimate acquisition and distribution of resources and power. Bankers have a magic touch and deserve riches, while the labouring masses should be helped to survive recession. But the marginal are those for whom there is no place (or at best a residual place) in the taxonomy. The work-shy proliferate children, pollute the planet, and should be sterilised. Mary Douglas has shown how a single (false) diagnosis of a disease (leprosy) was used in medieval Europe first to stigmatise representatives of a crumbling hierarchy, and then to marginalise the landless poor. These changes in the polarity of accusation (she argues) are evidence of important shifts in the organisation of early European society. There is no escape from taxonomy, she implies. All societies will target some groups and marginalise them as a way of protecting core values and functions. The important task is to establish, through analysis, what features of the system drive stigmatisation. That is the direction in which protections and remedies might be sought. Where her approach needs to be expanded is in relation to the complexities of globalisation. There is no single authority to underpin a stable taxonomy of threats to the world system. Civil society, the state, and the trans-national institutions develop competing schemata of marginality and insidious harm. It is an urgent task to bring interpretive clarity to the ways in which these new social taxonomies are produced. In this paper I trace some of the ways in which young labouring men have come to be seen as a source of insidious harm in one resource-rich African country, and how they then reclassified themselves through rebellion. Analysis establishes links between this presumed danger and the slave trade, colonial courts, mineral extraction and global conservation. What is the long-term stable solution to this presumed ëpidemicöf stigmatised young men?

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Marginal Soils

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The term "land" refers to the terrestrial bio-productive system that comprises soil, vegetation and other biota, hydrological and ecological processes and entities which provide a range of ecosystem services and functions. Soil is an integral component of land, and is the essence of all terrestrial life. It is the 3-dimensional body on the surface of the earth, and the interface between the lithosphere and the atmosphere. Soil, or the pedosphere, strongly interacts with the hydrosphere and the biosphere, and is the most basic of all natural resources. It affects and moderates gross/net/biome and ecosystem productivity, cycling of water and elements especially that of C (N,P,S), climate and the energy budget, denatures and filters pollutants and thus purifies water, stores germ plasm and influences above and below ground biodiversity, and is also an archive of human and planetary history. World's soil resources are also finite in extent, unequally distributed among eco regions, prone to degradation by natural and anthropogenic factors, have inherent resilience, and are renewable over the geologic time scale.

Despite their importance to ecosystems health and human civilisation, soils are being marginalised and treated as a global common good. Consequently, the soil resources are degraded by a range of processes such as decline in soil structure and tilth leading to crusting and compaction, accelerated erosion by water and wind, secondary salinisation of irrigated land, depletion of soil organic carbon (SOC) or soil organic matter (SOM) along with that of essential plant nutrients (*i.e.* N, P, K, Zn, Cu), acidification, elemental imbalance, and reduction in activity and species diversity of fauna and flora (macro, meso, and micro organisms). Thus, soil degradation entails decline in its physical, chemical and biological quality with the attendant adverse effects on ecosystem functions.

Marginal soils are soils of poor quality, and characterised by low eco system functions and services. Marginal soils may be created by natural (*i.e.* too steep, too shallow, too rocky, too dry, too wet, too cold or inaccessible) or anthropogenic (human-induced) factors. The latter (*e.g.* accelerated erosion, secondary salinisation, depletion of SOC) is caused by land misuse and soil mismanagement.

The Law of Marginality (Lal, 2008b; 2009 a;) states that "marginal soils cultivated by marginal means produce marginal yields and support marginal living". Yet, the biophysical process of soil degradation is driven by social, economic, cultural and other Human dimensions. Indeed, when people are poverty stricken and desperate they pass on their sufferings to the land. In addition to poverty, soil degradation is also caused by human greed, short sightedness and cutting corners for quick economic returns.

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Poor governance and lack of political will power to implement conservation-effective and restorative measures are major factors affecting soil degradation. The vicious cycle and the downward spiral "lack of investment in soil management ‰ accelerated soil erosion and depletion of SOC and plant nutrients – human malnutrition and food insecurity – political unrest and social/civil strife – severe degradation and desertification of soil and natural resources" reinforce one another, create positive feed back because of perpetual soil mining and use of extractive farming practices. Soil degradation, caused by land misuse and soil mismanagement, is a principal reason for inadequate human nutrition and poor health (Lal, 2009 c).

The SOC amount and its composition in the root zone are important determinants of soil quality which affects soil functions and ecosystem services. There is a threshold level of SOC concentration, 1.0 to 2.0 % in the root zone, below which soil processes and use efficiency of inputs are severely impaired. Marginal soils in developing countries of sub-Saharan Africa, South Asia and other regions, often have SOC concentration of < 0.5 %. Thus, marginal soils of low SOC concentration and low effective rooting depth do not respond to inputs such as improved varieties, fertilisers and irrigation. The yield potential of improved varieties can only be realised if grown under optimal soil conditions. While both traditional breeding and genetic engineering are needed, even the elite varieties cannot extract water and nutrients from marginal soils where these do not exist. The low level of SOC in marginal soils is caused by the negative C budget created by extractive farming practices of removing crop residues for numerous uses (*e.g.* animal feed, construction of houses and fences), use of animal dung as house hold cooking fuel, and lack of or insufficient input of fertilisers and soil amendments. It is not possible to take more out of a soil than what is put in it without degrading its quality. Only by judiciously replacing what is taken can a soil be kept fertile, productive and countries by 1 t/ha in the root zone can increase food production by as much as 50 million t yr^{-1} (Lal, 2006; 2010b).

Marginal soils can be restored through sustainable intensification. The latter implies improving productivity andecosystem services (*i.e.* carbon sequestration) while also restoring environmental quality. The strategy is to produce more from less while reducing the environmental impact and negative externalities. The goal is to create positive ecosystem C (along N, P, S) and water budgets in marginal and degrade soils. While there is no panacea, there is a menu of options to choose from for site-specific situations. Sustainable intensification implies the use of modern innovations built upon the traditional knowledge and wisdom. It is not a question of either or. Those who refuse to use modern science to address urgent global issues must be prepared to endure more sufferings because todays problems (7 billion people increasing at the rate of 75 million per annum and projected to be 9.2 billion by 2050) cannot be solved by yesterday's technology. Some recommended management practices(RMPs) include conservation tillage, mulch farming, cover cropping, integrated nutrient management and manuring, precision farming, water harvesting and recycling through

drip sub irrigation, fertigation, deficit irrigation or partial root drying, aerobic rice, bio char etc. Sustainable management of soils is the engine of economic development, political stability and transformation of rural communities in developing countries (Lal, 2004; 2010a).

Marginal soils are a transnational issue. Thus, each country and every land manager and farmer is cause and victim of this global problem, albeit to a varying degree. For example, mining SOC by extractive farming has the same effect on global warming as does fossil fuel combustion. Restoration of marginal soils and adoption of RMPs on soils of managed ecosystems have a technical potential of sequestering 1.2–3.1 Gt C yr^{-1} for as long as 50–100 yrs until the C sink capacity is filled (2010a). In combination with C sequestration in forest biomass, the draw down capacity of terrestrial ecosystems is about 50 ppm of atmospheric carbon dioxide by 2100 or 2150.This is the most natural and cost-effective strategy of adapting to and mitigating climate changes with numerous ecosystem services. Thus, restoring marginal soils through sustainable intensification is integral to any solution to achieving the Millenium Developmental Goals, mitigating climate change and improving the environment. If marginal soils are not restored, crops will fail even if rains do not; hunger and malnutrition will perpetuate even with emphasis on bio technology and genetically engineered crops; civil strife and political instability will plague the developing world even with sermons on human rights and democratic ideals; and humanity will suffer even with great scientific strides. Political stability and global peace are threatened because of soil degradation, food insecurity and desperateness. The time to act is now (Lal, 2008 a).

Adoption of RMPs for restoration of marginal soils in developing countries has lagged behind because small land holders are resource poor and cannot invest in the inputs required. Thus, adoption of RMPs must be promoted by incentivizing the farming communities. The strategy is to reward land managers through payments for ecosystem services (*e.g.* carbon sequestration, green water credits, bio diversity enhancement). This must be done by a fair, transparent and a just pricing process. Payments for ecosystem services is a better strategy than the subsidies and handouts. Emergency aids and other knee-jerk approaches have created dependencies, killed initiatives, ruined self esteem, increased corruption, and distorted values. By payments for ecosystem services, farmers must be treated as clients and not as aid recipients.

As agronomic productivity sputters. As food production lags behind the demands, as hunger and malnutrition adversely affect human health and well being, as soils marginalise and degrade, as natural waters pollute and contaminate, as climate warms and biomes shift and cannot adjust, as biodiversity dwindles and environment deteriorates, as ecosystem integrity and its functionality are jeopardised, there will be a growing realisation among policy makers that taking soils for granted has been the root cause of the downward spiral.

The reasons for stalling of the Green Revolution in South Asia and of agronomic stag-

nation in sub-Saharan Africa is the widespread problem of marginal soils exacerbated by the extractive farming practices, poor governance and lack of political will. The developing countries have the capacity to feed the present and future populations on sustainable basis with judicious management and restoration of marginal soils.

Given the right incentives through payments for ecosystem services, local win-win options are awaiting implementation. Now is the time to usher the soil-based and long-lasting Green Revolution in developing countries while improving the environment and promoting peace and communal harmony.

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Marginal people

Food policy and food security

Ethics in Agricultural Sciences: Development and Implementation in the University's Curricula

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Transforming the global food systems in a sustainable manner requires new direction in agricultural research and practice. Researchers bear great responsibility. They collect and publish sensitive data dealing with the human and environmental subjects. Especially in the interdisciplinary field of agricultural sciences, a social, economic and environmental friendly food production depicts the base of our well-being. Agricultural scientists must be aware about norms and values interlinked with their research practice and therefore require systematic and critical methods to incorporate ethical approaches. By introducing ethics at the university students are expected to improve their ethical expertise balancing contradictory evidence and analysing controversial science.

With regard to the growing scope of duties as a researcher, students of Hohenheim initiated and successfully completed the first round of the module "Ethics of Food and Nutrition Security" which was held for the first time in the winter term 2010/11. An interdisciplinary teaching concept was created in a participatory approach with experts from both inside and outside the university. The designed master level course combines ethical theoretical background with interactive lectures on issues of food and nutrition security.

Based on the course evaluations, adaptions and improvements are being incorporated to facilitate the course's aim to analyse and articulate ethical dimensions of agriculture. New instruments have been developed to measure empirically the effectiveness of teaching ethics and ethical competence through a pilot study developed within the module.

Positive feedback from the course participants shows the importance of implementing the module in the curricula of the university. This strengthens the call to mainstream ethical training into agricultural education worldwide.

Keywords: Applied ethics, ethical teaching, master module, social responsibility, student initiative, sustainable agriculture

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Economics of the Arab Awakening – From Revolution to Development and Food Security

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Few observers would have predicted the dramatic changes that are bound to transform the Arab world. Arab governments appeared to be in tight control, and many Arab economies were growing around or above world average over the past years. Official poverty rates in most Arab countries are lower than in many Asian and Latin American countries, and people generally associate historical sites and beaches rather than poverty and malnutrition with Egypt and other countries in the Mediterranean region. However, slow progress in economic diversification, lack of job creation, social inequalities and persisting food insecurity have long been identified as major development challenges for Arab countries.

In this paper, we use fresh data from Gallup World Poll and the Global Database on Child Growth and Malnutrition to shed light on the role of economic factors in the run-up of the revolutions. The findings confirm the notion that the dissatisfaction of people with their standards of living and food security likely contributed to the uprisings. We also show a growing disconnect between economic growth and alternative social indicators (such as child malnutrition) over the past years in countries like Egypt; a trend that is not obvious when looking at traditional indicators such as poverty and GINI coefficients. This finding raises important questions about the underlying causes as well as the suitability of the typical (income based) poverty indicator.

A key message of this paper is that in addition to giving people a voice and tackling governance failures of the past, rapidly getting the economic fundamentals right should be a top priority for any new Arab government. There is a real risk that people may get disillusioned quickly with political achievements of the revolution when the revolution fails to improve their daily living standards. Solutions need to be found urgently for key questions such as a) Which actions can be taken to stabilise countries in the aftermath of the uprisings and improve living standards and food security of the people rapidly? b) How can economies be transformed and patterns of growth be changed so that growth creates jobs and reverses growing disparities?

Keywords: Arab world, economics, Egypt

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Exiting Poverty in Rural Kenya – How Much Does Natural Resource Endowment Matter? Results from Poverty Dynamics and Agricultural Life History Interviews

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After decades of neglecting the role of the agricultural sector for development in rural Africa, many now (re-)recognise its importance. The recent food crisis has also contributed to a fresh look at the dynamics of the agricultural sector in African economies. Hence, development agen-cies, governments and private sector invest lots of resources to integrate particularly smallholder farmers into markets and value chains in order to reduce rural poverty. This strategy seemed to work reasonably well for farmers involved in high-value export crops in high-potential areas. But what are the impacts for poorer African farmers in marginal areas? Why do some rural households exit poverty due to agricultural activities and some don't? And do rural households in well endowed agro-ecological zones succeed more in improving their living standards by spe-cialising in agricultural activities or by income diversification into the non-farm rural economy?

This research states that even though agro-ecological resource endowment plays an important role for the agricultural production system pursued, its importance for household welfare is less significant than expected. This result is based on rural poverty dynamics in Kenya. Household panel data and life-history interviews are used in a mixed-method approach, following the q-squared paradigm of combining quantitative and qualitative analysis. From a four-wave panel data set comprising 1275 rural households in eight different agro-ecological zones, half of all poverty exiting households were interviewed in-depth about their agricultural history. The narrated reasons for changes in household welfare are compared with their agricultural factor en-dowment and productivity. Results indicate that poverty-exiting households can be found in all high and medium agro-ecological zones, but less so in marginal areas. Household demography, in particular family labour requirements and social expenses, seem to play an almost equally important role like crop and livestock productivity for exiting poverty. It is argued that such typical social developments need to be taken into account to reach out successfully to the rural poor in marginal areas in comparable African settings and thus, to deliver on the promise of pro-poor rural growth.

Keywords: Kenya, life histories, Q-squared paradigm, rural poverty dynamics

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Ultra Poverty and Vulnerability in Northern Highlands of Ethiopia: A Panel Data Evidence

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Access to longitudinal data sets in Ethiopia has given momentum to the study of poverty dynamics in the last couple of decades. A preliminary assessment of smallholders' consumption expenditure reveals that ultra poverty is paramount in northern highlands of Ethiopia. Also, a thorough analysis on the dynamics of rural household poverty requires income group analysis approach than a mere poor and non-poor categorical analysis. This study is therefore primarily intended to examine the dynamics and determinants of rural household poverty and vulnerability in northern Highlands of Ethiopia. The data for this research is based on the Ethiopian Household Survey conducted by the Department of Economics, Addis Ababa University for six rounds starting from 1994. In addition to this, primary data was collected from a sample of rural households in the selected villages for the year 2010.

The paper attempts to show the dynamics of rural household poverty in Northern highlands of Ethiopia by mainly using transition matrices and Foster-Greer-Thorbecke (FGT) indices. It also tries to scrutinize the likelihood of rural households of moving up, down or remain in the same income deciles across the panel years. Moreover, the study goes further to investigate the basic determining factors for rural household poverty using both Fixed Effects Instrumental Variable Regression and Generalized Multinomial Logit Model. Analyzing the vulnerability of households to poverty in the selected villages will be given sufficient treatment in this study. Finally, the research will draw policy implications that will be used by both policy makers and other researchers targeting on poverty reduction of rural households in northern highlands of Ethiopia.

Keywords: Rural Ethiopia, ultra poverty, vulnerability

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The Global Food Crisis and Food Security in Tajikistan

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As a result of both internal (price, land and institutional reforms) and external (trade) factors, food security in Central Asian countries has improved significantly since the mid 1990s. However, the recent surge in global food prices shows that the countries of the region, especially Kyrgyzstan and Tajikistan, are highly vulnerable to external shocks. This paper examines the impact of recent global food crisis on domestic food security and household welfare in Tajikistan, a country with an extensive rural population (74 %), a high poverty rate (about 40 %), and a large share of rural households engaged in agricultural sector. First, we thoroughly analyse the transmission from global to domestic food prices using time series analysis. Then, using the 2007 and 2009 Tajikistan Living Standards Survey (TLSS), we examine the welfare effects of increasing food prices at the household level. The sample size in the 2007 TLSS was 4860 households. The 2009 TLSS is a panel survey of 1500 households from the 2007 survey. The theoretical foundation for this analysis is a concept similar to that of compensating variation, which is the money-metric change in welfare due to changes in food prices. We show the heterogeneity of impacts of the food crisis across different segments of households (rural, urban, farmer, non-farmer, size of land, mountainous and remote areas, etc.). This has important policy implications because understanding the heterogeneity of impacts allows for the design and targeting of specific policies aimed to support different segments of the population. The paper also discusses the major constraints on long-term food security in the country.

Keywords: Agriculture, food prices, food security, global food crisis, household welfare

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New Changes, Challenges and Responses for Chinese Rural Institutional System – Empirical Case of Manggang Village in Yunnan, China

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The marketisation reform in China has been carried out for more than thirty years. In Chinese rural areas the reform deeply affects socio-economic life, challenges traditional social system and demands new appropriate institutional forms for its further development.

MangGang village is a natural village in GoLiGong Mountain area in Yunnan, which is one of UNESCO world heritages. It is deeply influenced by market economy despite of its remote location. Because of its cash crops production, such as coffee and sugarcane, it has become a relatively wealthier village and indirectly assists the economic development in other poorer villages nearby. Its function as a leading role is significant. On the other hand its traditional institutional structure is facing increasing challenges as a result of marketisation. It becomes difficult to coordinate the requirements from economic development, public service, labour optimisation and biodiversity protection. Government, farmers and grassroots NGOs attempt to solve these problems in their own ways. However an efficient governance system which will be able to support its social, economical and environmental developments in a sustainable way has still not been found.

The paper examines the new demands and challenges came from marketisation in local institutional system. The socio-economic changes in MangGang over the last ten years will be outlined. To deal with institutional voids, the activities and efforts in government, farmers and grassroots NGOs will be evaluated on the basis of each contribution to a sustainable development. From a social capital perspective, the community-based development strategy in MangGang will be researched. Finally the feasibility and possible functions of fair-trade movement will be critically discussed in terms of resource organisation and coordination among various actors.

Keywords: Governance system, marketisation, rural institution, socio-economic changes, sustainable development, Yunnan, China

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Institutional Change in the Transition Process of Smallholders: A Case Study in North Sumatra / Indonesia.

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The world is facing finite energy resources and therefore sustainable and renewable energy supply will become increasingly important in the near future. An energy crop that has become highly debated within the last years is oil palm. One reason for this is the increasing competition for land traditionally used for food production, adding to rising food prices, poverty and hunger. In Indonesia, small farmers are increasingly shifting away from staple rice to oil palm production. The problem comes into sight in the institutional settings which are types of rules-in-form and rules-in-use shaping social relationships and governance structures which do not ensure social, economic and environmental soundness of the transition from staple crop to oil palm production. The general objective of this research is to understand the co-evolution of traditional and new institutions and its impacts in the transition from staple crops to oil palm production. A specific objective of the study is to describe the changing setting and to assess how traditional and new institutions have co-evolved in the transition from staple crops to oil palm production. Further, the analysis aims to identify characteristics of the transition process and the prevailing institutional setting that promote or hamper sustainability and food security in smallholder communities. The transition from staple crop to palm oil production was analysed based on information from semi-structured interviews with stakeholders in North Sumatra, Indonesia. The findings indicate that external effects, including heavy flooding, water pollution from nearby oil refineries, price policies and bioenergy production incentives have contributed to the shift from rice to oil palm production in smallholder communities. Traditional institutions prove to be non-performing in the new setting and institutional change has been insufficient to regulate the social and environmental impacts resulting from the transition. This process is gradual and rapidly going on eroding existing institutions and is leading to a situation where food security and sustainability is not ensured through a staple system. As a consequence the problems observed may not be solved with the existing institutions and governance structures. We conclude that governance structures are needed that allow for adaptations and institutional innovations.

Keywords: Biofuel, food security, governance structures, institutions, palm-oil

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Evolution of Rural Land Right Systems and China's Internal Migration

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This paper analyses how the evolution of rural land system has influenced the internal migration of China from the foundation of People's Republic of China in 1949 to the early 21st century. Especially it tries to find out how the new policy which promotes land transfer in rural China has influenced the pattern of labour transfer at the beginning of 21st century.

Scholars of structuralism argued, society or the social structure is a precondition for the individual and the purpose of structure is to delimit individual acts (Olof Stjernstroem 2004). In China, migration is closely linked to insecurity of land rights, as "village land ownership remains collective and land use rights can be periodically reallocated, individual out-migration can result in deprivation of those rights." (Li Shi 2009). Thus migration is not solely to be analysed with reference to the individual experience of the migrant, but also with reference to social and institutional factors in regions of origin.

The present paper aims to find out which relationships have existed between land policy (i.e. the government's and state's regulations of land rights and land management) and migration movements. It focuses on the rural region of Hunan Province in China and starts from the following hypotheses: 1.There is a close relationship between land rights and migration. 2. Rural return-migration increased with the strength of individual land rights by the land policy.

Desk-top research on the basis of a literature review and the analysis of secondary data from the National Bureau Statistics is conducted as research method. The paper is structured as follows. In the first session we discuss state of research on the links of land use and migration. In the second section we illustrate the links between land use and internal migration of China in the past decades. The third section shows empirical evidence for the impact of the New Policy of Land Rights on return migration at the beginning of 21st century. In the last section conclusion is drawn from the data analysis.

Keywords: Internal migration, land policy, land right, return migrant

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Emission Taxation under the Presence of Bribery: Experimental Evidence Inspired by the Indonesian Case

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Deterioration of environmental quality is an important issue in Indonesia. The implementation of emission tax has been mainstreamed since 2008. However, the success of an emission tax is potentially hampered by several problems. The first problem concerns the conflicting objectives between government and industry. While the government seeks to reduce emission augmenting fiscal income, industry has an interest to elude taxes and raise profits. Within this field of opposing interests the issue of asymmetric information poses a challenge which is difficult to overcome. Monitoring helps to reduce information asymmetry but is costly to government, enabling the industry to take noncompliance action. Furthermore, the presence of bribery practice in the taxation directorate may hamper tax compliance further. The objective of this study is to provide clues about the impact of alternative principal agent design options on tax compliance under the presence of corruption. Design alternatives in our experiment include different combinations of tax rate, sanction rate, financial reward rate, and probability of audit. Our experimental set up also takes into account the presence of bribery in the taxation office and incorporates a bribe rate as a determinant of compliance. The experiment was conducted in Indonesia, with university students as participants. The experiments showed that under the absence of bribery, the compliance was mainly determined by audit intensity and sanction severity. The introduction of a financial reward for truthful emission reports increased compliance behaviour of participants. However, in a treatment with bribery, the use of a financial reward had no longer a significant effect on compliance. Under bribery, the price of the bribe significantly affected the behaviour of participants and tax increases were responded to by lowering the compliance. The results indicate that the easiest way to influence compliance is by setting a moderate tax rate, since tax compliance deteriorates with increasing tax levels. Furthermore, compliance can be increased by bringing down bribery which can indirectly be induced if the cost of bribery increases, for instance, by setting a severe punishment for bribe-receiving officers. Finally, only if bribery can be curbed, controlled financial rewards can be applied as a compliance incentive.

Keywords: Corruption, emission tax, environment, experiment, tax compliance

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Transaction Costs Arising from Breaches of Legal Contracts – The Case of Judicial Breaches of Contracts of Anticipated Sale Contracts of Soybeans in Brazil

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Anticipated sales of commodities reached a significant importance in modern economics. They represent the main mechanism of economic exchange and of guarantee of fulfilment of mutual obligation commitments. In Brazil, the anticipated sale of commodities is one of the main funding mechanisms of agribusiness, particularly for commodities like soybeans and corn. In this scheme, part of the production is bought and paid by the buyer during planting of the crops. Contracts are instruments designed to ensure greater legal certainty to economic transactions. Efficient economies are governed by rules of public and private character, but private arrangements have special focus on these scenarios, and its efficiency is directly proportional to the degree of reliability in fulfiling obligations. Brazil's agribusiness is one of the economic sectors most susceptible to the effects of judicial decisions, because it is also highly regulated in comparison to other areas like trade and services. It is noticeable that judicial decisions related to those contracts generate direct effects on markets, increasing or decreasing transaction costs, since in Brazil the Judicial Power represents the main arena to solve conflicts of interest. In this scenario, the Brazilian judges tend to be tolerant with the relativising of the effects of laws and contracts, modifying agreed obligations in order to generate equity and pursue social justice. Knowing this reality, Brazilian soybean growers show opportunistic behaviour breaking anticipated sale contracts avoiding delivery of their soybean production to buyers, generating instability in agricultural sector, producing additional costs to production and causing loss of competitiveness.

Keywords: Contracts, judicial breaches, transaction costs

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A Newly Born State in Africa: Economic and Agricultural Development Prospective

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In January 2011, the people in southern Sudan have voted for separation from the Sudan and forming a new state in Africa. Accordingly, the newly born state was officially announced as a sovereign country on July 9, 2011.

The formation of a new state has beside its political dimension, several economic implications. Some are urgently important for both the Sudan in the north and southern Sudan such as the assets and debts, with the latter estimated at around US$ billion 35. In addition, oil of which 80 % comes from the south, while the entire infrastructure for utilising the exploited oil including refineries, pipelines, and export terminals are located in the north. Many constraints prevent exporting the southern oil through the Kenyan port of Mombasa including costly infrastructure to be developed. Even if there will be sufficient funding for establishing such infrastructure, its establishment would take four to five years, where the government in southern Sudan cannot easily survive without the cash flow generated by oil, which constitutes 98 % of its financial revenues.

Agriculture in southern Sudan has long stagnated due to instability, which should take the lead recently together with the infrastructure development. In the north, agricultural exports would need to restore its importance as oil revenue drastically cut. Regionally, according to Business Daily Africa, forming the new state will have major implications on Eastern Africa, where Kenya seems to reap billions from that state, followed by Uganda.

Based on this background, this study tries to investigate the economic implications the formation of the new state may have. It focuses on the response of the economies in the north and south with particular focus on agriculture. It also shed lights on possible implications on the entire region. The paper analyses empirically the gains and losses associated, while simulating the situation in a global modelling framework to grasp the related implications on selected neighbouring countries as well. More specifically, the study employs GTAP model and its Africa database with Sudan, Egypt, Ethiopia, Kenya, Congo, and Uganda separately represented together with rest of the world grouped purposely into other seven regions.

Keywords: Africa database, agriculture, development, economics, GTAP model, southern Sudan, sudan

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Customary Land Access and Accountability in Ghana: Effects of Land Allocation Practices on Local Livelihoods

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This paper examines the dynamics of changing practices of customary land allocation and its effects on local livelihoods of people whose only means of survival depends on farming. With the dearth of alternative employments in rural and peri-urban communities, of Ghana, agricultural production becomes the only means of survival of folks. However, in the context of emerging land marketisation, fueled by de Soto's idea of 'awakening the dead capital', realisation of the objective of marginal people to improve their welfare through increased agriculture is becoming impractical, as their rights to land are being eroded.

Chiefs and heads of families exchange 'communal' lands for money, on the account that such lands are losing their agricultural value. Moneys realised from transfer of lands are also not accounted for. Embedded however within the social fabric of the community is a hierarchical structure of power imbalances, which makes it difficult for poor and marginal people to revolt and stop these heinous activities by their leaders. In the absence of any corrective measure, local people risk losing rights to their lands, poverty may increase and future of the community may be jeopardised.

We question, how these actions of chiefs and heads of land owning groups are impacting on livelihoods of marginal people whose entire lives depend on farming. Using data obtained from a recent field work in Ghana, we focus on the effect of land marketisation and/or rising cost of land leases on the livelihood of rural and peri-urban marginal lands. We show how inspite of government's policies to enhance accountability in customary land management, chiefs and heads of families are able to use excuses of marginality of land to sell communal farmlands without rendering account. We hope the findings of this study will help fine tune the current processes of land administration projects .

Keywords: Accountability, chieftaincy, Ghana, marginal lands

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Developing Marginal Land through FDI in Commercial Agriculture? Early Impact of "Land Grab" in Ethiopia

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Ethiopia is at the forefront of African countries leasing out substantial amounts of agricultural land to foreign investors. In the years 2004 to 2009 alone it has allocated approximately 1,190,000 hectares to foreign and domestic investors. This period has, however, to be seen with a much longer history of land deals. Since 1991 the regime has been allocating leasehold over large tracts of land, with significant differences across regions.

The motivation of the recent increase in land leased out, is to save foreign currency, boost food supply and trigger rural development through the injected capital. Critics arise as in how far local population in areas invested in is taken into consideration during acquisition of land and development of the new agricultural foreign direct investments (FDI).

Gambella is one of the poorest regions in Ethiopia, but the very place where most acquisitions have been taking place in the past two years. The paper will discuss a case study of one recent large-scale investment in a remote and marginalised region, to validate the impacts on the ground with regard to employment generation, land use conflicts and participation of local communities in the early stage of establishing large-scale agricultural production sites. Results from a small-N HH-Survey showing socio-economic indicators of two mayor local ethnic groups in six villages surrounding one large investment, will be combined with qualitative data from focus group discussions to illustrate early stage impacts and likely future developments. Main channels of impact are employment generation, change in access to natural resources and broader infrastructure development within the area and villages affected. Such local-level analysis in the remote, marginalised region of Gambella will be coupled with a broader overview on land-acquisitions in Ethiopia since 1991 and differences across regions and time.

Keywords: Africa, employment, FDI, inequality, large-scale land acquisition, poverty reduction, rural development

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Is it Really 'All for Africa'? – The Fraudulent Social and Ecological Argumentations of Oil Palm Developing Institutions

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The increasing world-wide demand for palm oil is leading to increased investments also in Africa, especially after the deforestation ban in Indonesia. In order to 'sell' their strategies to socially and ecologically responsible shareholders and international organisations, local government officials and agro-investors argue for palm oil development using keywords such as 'economic development', 'poverty alleviation' and even 'nature conservation'. Based on a case study from the Korup region, West-Central Africa, we show that such argumentations may be flawed and even fraudulent, by comparing the probable future livelihoods of people of 38 villages after creation of a 60,000 ha oil palm plantation with their current economic situation. We also discuss the potential effects of oil palm development for the protected areas in the region. Based on a sample of 194 households from seven villages in the region, the current yearly income of the 38 villages located within the designated plantation area can be estimated at € 2,745,196 (€ 1,762 per household, mainly from farming). Based on estimates of household size, this equals a daily income of 1.4 € person^{-1} day^{-1} and is well above the poverty line of 1 US$ (0.70 € person^{-1} day^{-1}). After creation of the plantation, resources currently free but very important to people (water, firewood, food and other forest products and ecosystem services) would likely disappear, leading to migration and increased pressure on protected areas. A concerted international effort is needed to increase pressure on African government officials to halt such developments and to guide investments in Africa into more sustainable and socially and ecologically acceptable endeavours.

Keywords: Agriculture, bioenergy, biofuel, industrial plantations, land use change, livelihoods

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Transfer of GMOs Technology in African Least Developed Countries: Relevant Socioeconomic Factors to Consider for a Sustainable Application

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The aim of this paper is to achieve an efficient and sustainable application of genetically modified organisms (GMOs) in African Least Developed Countries (LCDs) by strengthening the capability of research and political institutions, permitting the local development of the technology and its adaptation in relation to the specific characteristic of the key stakeholders. The diffusion of GMOs might not become the norm as theoretically foreseen *e.g.* by the neoclassical model, because of high uncertainty concerning its potential risks on the side of farmers and the environment, lack of participatory approaches to development, and low presence of local research institutions and human capital. This paper makes a contribution to approach the problem of food insecurity from a social and economic perspective: the evaluation has been carried out considering firstly the analysis of social constructivism and especially how technologies transform social systems. This analysis aims at finding out which aspects play a crucial role in evaluating the need and assessing the potentials of GMOs in African LDCs. From the economic perspective, the dynamics behind this technology transfer have been analysed through a Multiple Equilibria Approach in which *ex ante*, the undervaluation of socioeconomic aspects may be the cause of failure in the application of such technology, making ex post the rural economies move towards unfavourable equilibria. It considers the specificity of GMOs technology in order to make their application fully beneficial, sustainable, and economically desirable. The discussion emphasises that the theory of linear models may be reductive in describing the economic dynamics behind any technology potentially valuable to reduce the burden of food insecurity, hence suggesting a need for a situation-specific approach. This paper will propose optional paths that transfer of GMOs technology may take. This theory implies that, in the case of GMOs, case-by-case analyses are needed in order to shape the technology to local needs, social norms, interests and expectations. This ultimately implies to settle locally agreements about the goals, potentials, impact, and security of this technology in order to increase the likelihood of a sustainable application.

Keywords: African Least Developed Countries, food security, genetically modified organisms, GMO, multiple equilibria approach, rural development

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Assessing the Importance of Livestock for the Livelihoods of Rural People in South Kivu, DR Congo

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Agriculture in the South Kivu province of DR Congo has traditionally been characterised by mixed crop-livestock production systems. Since time immemorial, the Kivu highlands have been covered by grasslands that have been maintained by repeated burning. These areas provided feed for cattle in transhumance systems. However, the population of large livestock has dramatically decreased since the wars in the mid 1990s. A recent study revealed that, on average, livestock farmers own 3.8 cattle, 8.0 poultry, 2.7 swine, 7.1 cavies and/or 3.8 rabbits as livestock assets, being raised on a small piece of pasture land of about 0.06 ha.

To assess agricultural activities emphasising livestock production, a participatory rural appraisal (PRA) has been conducted in two locations. Miti is located 25 km North of Bukavu at 1700 m asl., whereas Tubimbi is at 77 km Southwest of Bukavu, at 1100 m asl. Focus group meetings were held with overall 85 in Miti and 80 participants in Tubimbi. Villages were mapped, resource flow was depicted, seasonal calendars were developed, daily gender activities were recorded and a wealth classification was performed to identify the importance of livestock. In Miti, 70 % of participants and 95 % in Tubimbi stated to hold any kind of livestock. While large livestock like cattle have lost importance, obviously small ruminants and monogastrics have filled the gap. In Tubimbi, aquaculture was also important, and people rely on gold mining to sustain their livelihoods.

Most problems of livestock husbandry reported were related to diseases and robbery, while the need for improved forages was less in the villagers' minds. When ranking general wealth classes, livestock played an important role in both locations. However, only owning large animals like cattle (together with land) and, to some extend, goats was regarded as an asset, whereas small livestock species like rabbits and cavies were clearly associated with poor and very poor population groups. Livestock sales are used to cover necessary expenses such as medicine or school fees. Resource flows are more intense in Miti and its vicinity than in Tubimbi due to lack of infrastructure and insecurity. However, current livestock production cannot satisfy the demand.

Keywords: Food security, livelihood, livestock, monogastric, tropical forages

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Agricultural Trade Between China and Africa: Dynamics and Prospects

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Agriculture plays a very important role both in China and African countries. There is a big difference between China and Africa with regard to their natural resources. Therefore, the trade of agricultural products between these two regions has obviously a complementarity. There is great potential for further bilateral cooperation between these regions. Whereas China and Africa have a similar industrial structure and trade imbalance, they are all developing countries, mainly producing labor-intensive agricultural products. The similarity in theses aspects makes the agriculture trade between them compete on the world market. By using data from the United Nations Comtrade Database Standard International Commodity Classification Revision III (SITSC Revision III), this paper firstly studies the trade situation of agricultural products between China and Africa, uses revealed comparative advantage index (RCA) and trade special coefficient index (TSC) to evaluate agro-products' export competitive capacity of each region, and then analyses the trade competition and complementarities by means of export similarity index (ESI) and trade intensity index (TII).
The results show that the bilateral trade between China and Africa has increased dramatically in recent years. However the share of China's exports to Africa out of its total agricultural exports has been very small. China mainly exports labor-intensive products to Africa, chiefly imports land-intensive commodities from Africa. There are big structure differences of agricultural export between China and Africa. Thus trade of agriculture products between Africa and China is highly complementary. Since the agricultural trade between the two regions is not directly competitive, China and Africa should consider to pay attention on promoting more general agricultural cooperation such as cooperation in areas of agricultural technology and management.

Keywords: Africa, Agricultural trade, China, competitiveness, complementarity

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The Perspectives of Primary Sector in the Booming Economy of India

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The Economic growth of most of the developing nations, were always been agricultural dependent. The agriculture being the primary sector for those nations, provide basic food security and the employment for most of the population. Especially, in the case of the dualistic economies, the situations were narrower. India, being historically such a nation, has progressed by structurally modifying the sectors of the economy, based on the Lewis-Fei-Ranis model.

In this research the author investigates the relevancy of the structural development model and its impact with the recent economic boom of India, especially over the primary sector. The author has done a case study in the Indian state of Tamil nadu, investigating the recent performance of the primary sector, which is primarily agriculture. The outcome reveals the long term impact of the structural development on the social behaviour of the folks of the primary sector and the future prospects of the sector in the state. The youth from the households of the primary sector have quitted agriculture, as 80 % of them neither have agricultural knowledge nor the interests to do agriculture. The problems that the agriculture faces like irrigation scarcity, exploitation of ground water resources, labour scarcity for agriculture, increasing literacy, increasing urban population, were found to be the structural model's advantage, took up in the post-liberalisation economy. The imbalanced sectarian focus in the economy, urbanisation and various resources´ scarcities for the agriculture were threatening the primary sector of the booming India. Though Lewis-Fei-Ranis model was considered as out-dated, India still follows the model partially and very lately after its intended period of introduction.

Keywords: Dual economy and imbalanced growth in India, Lewis-Fei-Ranis model, social behaviour

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An Outlook of World Food Price in 2020 – Determinants, Trend and Alternatives

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World food price has always been the central issue affecting food security and poverty alleviation in a global level. The sky-rocketing price of major agricultural commodities in the year 2007 and 2008 heated up this topic unprecedentedly. Effort has been made through a substantial amount of academic researches to explain the underlying determinants of the price fluctuation, as well as to explore the future trend. This paper will tempt to contribute to those analyses.

The main perspective of this paper is to summarise the underlying factors that influence the world food price and to construct a baseline scenario of the world price of several major agricultural commodities in the year 2020, based on the development of decisive macro indicators in the future years. To forecast the future, the past has to be introduced. Therefore, the paper will start with describing the significance of world food price issue, trying to list the major factors that may exert an effect to the volatility of price. Then in the second part, based on the statistics during the past years, those factors will be divided into two groups: the macro indicators such as the state of agricultural production, growth of population, increasing of GDP, international trade development etc.; other factors that recently appeared that are considered to play an increasing role in affecting world food price such as US dollar and oil price, production of biofuel and speculations in commodity markets. To put those factors together, in the third part, an overview of different models applied in previous study to explore the determinants of price fluctuation will be provided, following with comparisons of the pros and cons. After the overview, a sophisticated CGE model- GTAP will be selected to construct the baseline scenario in year 2020 integrating the macro indicators proclaimed in part 2. Accordingly, sensitivity analysis will offer an explicit explanation of impact of other indicators. Finally, present of the results and possibilities of incorporating other factors into the scenario will be discussed and conclusion will be drawn.

Keywords: 2020 baseline scenario, determinants, world food price

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Preference Erosion: The Case of Everything But Arms and Sugar

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Every change in policy creates winners and losers. One recent example for this truism is the introduction of the European Everything But Arms (EBA) initiative, particularly the recently implemented sub-section legislating the import of raw sugar. Associated with this policy is the change of the European Union Common Market Organisation (CMO) for sugar.

The EBA, an agreement between the group of the world's 48 so-called Least Developed Countries (LDCs) and the European Union (EU) granted market access for the LDCs for all products except of weaponries. The CMO was changed concurrently: In 2006, from when on LDC-quotas were gradually increased and tariffs reduced, the import quotas for Special Preferential Sugar (SPS), an agreement with the African/Caribbean/Pacific (ACP) countries, declined drastically. Together with a sharp decrease of the EU intervention price, these policies were targeted to reduce subsidised (re-)exports.

EBA is expected to be unambiguously positive for the benefiting LDCs, while the CMO reform is bad for both LDCs and ACP countries. As the LDCs are having unlimited access to the European market since 2009 through EBA, their loss is better described as reduced future gains in terms of export earnings. The ACP countries however, which have been enjoying preferential access to the European Market for decades, face now the lower price of the reformed SMO, a process called "erosion of preferences". In addition to that they are affected by cuts of their SPS-quotas.

The aim of this paper is the quantitative verification of these theoretically predicted impacts of the change of EU policies on the mentioned (non EU) countries, a heterogeneous group which differs widely with respect to their region, recent and colonial history and development states. The empirical analysis will be done with the estimation of a gravity model, laid out by Anderson and van Wincoop (2003). In the fixed-effect regression analysis with very recent data on trade (2002–2010), the variables of the biggest interest will be the ones indicating new policies.

Summing up, this analysis on global scale is highly relevant for the evaluation of the European Common Agricultural Policy with special respect to the Least Developed Countries.

Keywords: ACP, African Caribbean Pacific countries, EBA, everything but arms, LDC, least developed countries, preference erosion, preferential trade, sugar

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Promoting Regional Trade to Enhance Food Security: A Case Study on the Border Region of Tanzania and Zambia

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Food security is an issue of high importance for Sub-Saharan African countries. With the ongoing process of regional integration, the promotion of regional trade between neighbouring countries is one strategy to enhance food security.

The study introduces an Analytical Framework (AF) to evaluate the potentials of regional trade to enhance food security. Three working levels are defined: (1) A desk study to identify relevant countries or regions, (2) a fact-finding mission to collect in-depth data and (3) an assessment to evaluate the potentials.

The AF is implemented in a case study on crossborder trade between Tanzania and Zambia. Both countries are members of the Southern African Development Community and are intensifying co-operation and trade liberalisation.

Although being generally food secure, Tanzania still faces food shortages. The Government pursues an interventionist policy by purchasing food in surplus areas to sell these at subsidised prices in deficit regions. This is combined with several barriers for crossborder trade, *e.g.* an export ban on food staples.

Zambia's food security policies are biased towards maize as major food staple. The Government intervenes on domestic markets and provides farmers with subsidised inputs. Zambia's Northern Province is generally food secure but Zambia sometimes faces food shortages. The Mbeya and Rukwa Regions in Tanzania have favourable natural conditions. The productivity of the agricultural sector is above national level and the area produces surpluses.

Import quantities to Zambia are influenced by the imposed export ban. Besides formal trade, the importance of informal cross-border trade with maize has increased. Trade is hampered by a number of non-tariff barriers, ranging from cost-intensive and time-consuming customs procedures to road blocks. Most of the non-tariff barriers are relevant for formal and informal trade.

The assessment of the policy measures shows conflicts of interests between national food security on one side and agricultural trade liberalisation on the other side. Market interventions have negative effects on trade in general. Additionally, the Tanzanian export ban creates disincentives for farmers and traders. The assessment shows potentials for increasing the crossborder trade between both countries. The recommendations concentrate on the potentials to expand their involvement in trade.

Keywords: Analytical framework, cross-border patty trade, export ban, food reserve policies, food security, food security policies, informal trade, market interventions for food

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The Assessment of Food Vulnerability in Sahel Countries: Case of the Early Alert System of Niger

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In this poster, an original methodology of the assessment of food vulnerability is explained and implemented. The definition of food vulnerability is "the analysis of adaptation mechanisms and reaction faced with a difficult situation. If the mechanisms aren't effective, the household is in a temporary or structural vulnerability situation" (SAP and INS, 2010). The early alert system of Niger has existed since 1989. This system analyses the food vulnerability in vulnerable areas every year and every month. This analysis identifies the area and population most at risk. Every year, at the end of the agricultural campaign, the monitoring draws up a vulnerability index. This index varies between zero and one hundred. Each department is classified in four classes: famine condition (from 76 to 100) ; extremely vulnerable (51 to 75) ; vulnerable (26 to 50) ; relatively vulnerable (0 to 25). The calculation of this index is realised from data in an identification form. In this form, ten variables are identified: the pluviometric situation (9 points); the food producing situation (50 points); the cash crop (50 points); the pastoral situation (50 points); the income sources (50 points); the market state (10 points); the nutritional and health situation (6 points); the alert component (5 points); the adjustment capacities (10 points); the diagnosic of the previous year (10 points). The notation is obtained after application of a weighting on some variables. This assessment is the only methodology that analyses all departments of the Republic of Niger. However, this analysis doesn't consider the economical and physical accessibility and the level of this analysis is too extent. In the future, this level should be more detailed.

Keywords: Assessment, early alert system, food, Niger, vulnerability

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On the Relationship between the Share of Nutrient Consumed across Selected Food Groups and Income in Nigeria: A Long-run Demand System

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The objective of this study is of two folds. First, to take a critical look at nutrient consumed and its trends and secondly, to examine the relationship between share of nutrient consumed across selected food groups and per capita income in Nigeria. Three nutrients consider in this paper are daily per capita calorie, protein, and fat intake based on annual series from 1961 to 2007 and supported by real per capita Gross Domestic Product (GDP) as a proxy for national income. The composition of nutrients is grouped into five homogenous and non-homogenous food categories. However, the preliminary analyses shows that all the variables were found to be I (1) process at initial level while the series become I (0) after first differences. Besides, we cannot reject the null hypothesis of no co-integration in the series which motivated the use of long-run demand system specified in the first differences to address objective two. However, the result of the objective one showed that the average calorie, protein and fat intake are still below the recommended daily allowance since 1960s in Nigeria. Further analysis, revealed that diets in Nigeria remained very much cereal-base with cereals and root & tubers providing about 46 % and 18 % of total calorie, respectively while cereals provide about 54 % of total protein intake in the country as against about 12 % from animal products. Vegetable oil provides about 62 % of fat consumed while cereals based food stuffs provide about 15 %. In addition, the results show that the calorie, protein, and fat intake are growing at the rate of about 0.32 %, 0.31 %, and 0.17 %, respectively, from 1961 to 2007. With regards to the objective two, we found evidence that the calorie share of animal products, protein share of oil crop and animal products, fat share of cereal and that of vegetable oil, oil crops and animal products significantly respond to the respectively total nutrient intake across the food groups. The income elasticities also show that calorie, protein and fat share of animal products respond positively but inelastic to the per capita income growth in Nigeria within a space and time.

Keywords: Consumption pattern, demand system, food groups, Nigeria, nutrient intake

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Do Women Remain a Key to Agricultural Production and Food Security in Sudan? The Case Study of North Kordofan State

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Women represent half of the world population, and play a considerable role in both productive and reproductive activities in developing countries. However, their roles in agricultural production and food security are underestimated. Accordingly, this study aims at assessing the role of women in agricultural production and food security in North Kordofan state of Sudan. For the purpose of this study both primary and secondary data were used. The primary data were collected using structural questionnaire with 90 respondents, while secondary data were collected from different relevant sources. After data collection and clearing, descriptive statistics were employed as a method of analysis. The results revealed that women contribute 74 percent of the monthly agricultural income, 65 percent of the monthly household income, 62 of the total labour work for both food and cash crops and 65 percent of the household activities other than agriculture. Moreover, women work 45 percent greater than men, as they work for 14 hours per day while men work only for 8 hours. Women role in agricultural and food security should highly be acknowledged and their multiple roles in agricultural production, food security and house activities should fairly be accounted for in household and national statistics. Moreover, removal of the main obstacles facing women, such as lack of access to agricultural resources and services, is crucial. This can be achieved by reviewing and re-orienting government policies. Accordingly, women income will increase, their contribution to agricultural production will expand and their household's lives will improve and hence household food security will be realised.

Keywords: Food security, Kordofan, Sudan, women

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Socioeconomic and Ecological Factors that Determine Food Security Levels of Households in Central Rift Valley of Ethiopia

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Similar to most parts of Ethiopia, food security situation of households in the Central Rift Valley (CRV) region of the country is greatly influenced by the performance of rain-fed farming systems, which fluctuates with variability in rainfall. In order to improve the livelihoods of people in the area, there will be a great need to improve the performance of this sector. Although farmers in the area face nearly similar environmental conditions, the situation of their food security is usually diverse: some are frequently food-insecure while others are food self-sufficient. Therefore, this study was conducted to describe and analyse the current food-secure and insecure rain-fed farming systems. It also aimed at identification of factors associated with food-secure and insecure farming systems, and exploring future research needs and actions to improve the performance of rain-fed farming systems. A holistic systems analytical approach was used to make the analysis and the description. Three food-secure and three food-insecure peasant associations (Kebeles) were purposively selected for a survey. From each set of Kebeles, thirty-nine households were randomly selected and interviewed about both biophysical and socioeconomic features of the rain-fed farming systems. This information was supplemented with data from repeated farm visits, discussions with selected key farmers, other stakeholders and official records. Drought, shortage of agricultural land, and poor soil fertility were identified as major constraints in both food-secure and food-insecure Kebeles. On the other hand, the two categories of farmers were found to significantly differ ($p \leq 0.05$) in their farm management choices and decisions, coping mechanisms against shocks, time allocated to on-farm activities, soil fertility management practices, allocation of production resources towards more valuable crops, and manipulation of selling time of crops. Thus, it is not only what happens in their environment that creates differences between food security and in-security conditions among farmers, but also how they react to these environmental happenings and constraints can have great impacts. Therefore, focusing on socio-cultural issues in a way that improves farmers' perceptions and attitudes can contribute a significant part to any problem-solving agenda in the area, in addition to focusing on biophysical problems.

Keywords: Biophysical factors, ecological functioning, food insecurity, food security, off-farm employment, rain-fed farming systems

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Scarcity in the Midst of Piling Food Stock: A Case Study of India

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Indian economy in the present scenario witnesses a paradoxical situation where high food inflation is combined with increasing central pool of food stock. Wide range of policies *viz.* Public Distribution System (PDS) for BPL, food for work programme and programme for targeted women and children by mid-day-meal, fails to address the problem of marginalised section of society, which is evident from the fact that nearly 231 million people remained chronically under nourished. In contrast there was increase in the procurement of cereals in the government account: January 2010 the actual stock of rice and wheat was 474 lakh tonnes compared to 357 lakh tonnes in January 2009. Despite the Supreme Court's order to distribute the grains and the 'Right to Food Bill' the government still unable to resolve the cruel contradiction of overflowing granaries and widespread hunger. Consequentially the achievement of food security at the national level does not percolate down to the household level. In this context the study seeks to assess the economic consequences of food inflation (on consumption, income, wage, employment pattern, indebtedness, additional work burden on women, children and aged people) across states and communities in India. It also aims at analysing in what extent the rising food inflation and national agricultural strategies contribute to food insecurity in terms of both production and access to food across different segments of the population (small land holders, landless and the women) and across different regions (a primary survey undertook in Gujarat and Madhya Pradesh). A total of 200 samples were collected by using the 'Stratified Random Sampling Method'. The study indicates that (1) The surveyed households in Madhya Pradesh are more food insecure compared to Gujarat; (2) Landless households are more likely to suffer from hunger since nearly three-quarters of landless households suffer from hunger as compared to nearly one half of land owner households; (3) The households cope with the food inflation by declining consumption of traditional cereals; (4) Considering the small impact the PDS has for many households, it is perhaps necessary to rethink about the system.

Keywords: Agriculture, food security, India, marginalized community, public distribution system

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Markets & consumption

Strategies to Improve Smallfarmers' Market Integration in Marginal Areas: Synergies between Farmer Organisations and Contract Farming

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Economies where markets and services reach and work effectively for the poor have also achieved better results in terms of real poverty reduction. In developing countries, smallholder farmers are the major actors who can lead to agricultural development and inclusive growth. Improved smallholders' market access can in fact create employment, increase incomes and food security and lead to sustained agricultural growth.

With changing market trends, due to new consumption patterns and evolving agricultural marketing chains, the potential of high value crops, such as fruits and vegetables, is rapidly emerging for expanding market opportunities of small farmers in marginal areas. New opportunities for small farmers are also accompanied by challenges, related to conditions characterising still underdeveloped markets, particularly high transaction costs for market participation and business development.

This work aims to investigate strategies that improve framework conditions, reduce transaction costs and lead to an enabling environment for the integration of small farmers to established and new markets. High value crop markets which can offer high potential for growth particularly in geographically marginal areas are at the centre of the analysis.

The proposed strategy analysed by the research is the use of contract farming schemes through farmer organisations in order to reduce the transaction costs generated by lack of vertical coordination. Contract farming has in the last decades extensively been proposed as a promising institutional arrangement to better integrate farmers to new and established organised output markets. Working with farmer organisations can be an effective institutional arrangement to better include also smallholders within the contractual relations. The question is to assess the advantages and risks involved in implementing those contract farming schemes through farmer group facilitation, and to identify under which conditions the two approaches work best together. Some of the most important factors taken into consideration are the reduction of farmers risk's default for the contracting company, improved traceability and monitoring and the increased negotiating power for small farmers. Findings derived from literature on the topic and secondary data summarising mixed experiences from developing countries, provide the basis for further analysis during the field research in Uttarakhand, a North Indian State.

Keywords: Contract farming, farmer organisations, high value agricultural products, marginal areas, markets

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Modern Food Retailers and Traditional Markets in Thailand: Comparing Quality, Prices, and Competition Strategies

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In many developing countries, agricultural and food systems are undergoing a major transformation towards high-value and modern supply chains. There is an emerging body of literature analysing how smallholder farmers can be linked successfully to these chains, particularly in regard to the supply of fresh fruits and vegetables (FFV). However, opportunities and challenges for traditional retail markets, in particular wet markets, in changing food systems have so far been overlooked. This is an important research gap, as wet markets are still the major market outlet for smallholder farmers. Moreover, the bulk of FFV has traditionally been sold in wet markets. Accordingly, it is important to understand the implications of an increased competition with modern retailers for the traditional retail sector.

Using data from a market survey in Thailand, where modern retail chains have expanded significantly, we have analysed and compared quality, prices, and competition strategies between traditional wet markets and modern retailers. We have taken the case of sweet pepper and morning glory as examples, as these vegetables are typically cultivated by smallholder farmers in the northern mountainous regions of Thailand. Compared to wet markets, modern retailers sell higher quality at higher prices, indicating that they are primarily targeting better-off consumers. Hence, they are not directly competing for the same market segments. Given these findings, the rapid expansion of modern retailers seems to be more associated with the growth of high-quality, differentiated market segments rather than a direct competition for traditional market shares. However, over time the modern retail sector will likely adapt to various consumer needs and, through exploiting economies of scale, it will also be able to reduce prices and increasingly attract lower-income customers. Thus, traditional and modern market segments will gradually converge. Moreover, economic growth and globalisation lead to rising household incomes, better access to education and information, and rapidly changing consumer preferences towards higher-value products. Hence, modern retailers grow over-proportionally with economic development, partly at the expense of the traditional retail sector. This may have far-reaching social consequences along traditional supply chains, because wet markets are still the major outlet for fresh produce from smallholder farmers.

Keywords: Modern retailers, product quality, traditional wet markets, vegetables

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Banana (*Musa* spp. AAA-EA) Marketing in Uganda. Should Bananas be Weighed in the Future?

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In cooperation with banana farmers, banana marketing group leaders and bulk banana buyers, their knowledge and improvement suggestions regarding banana marketing were surveyed in Uganda. Banana group marketing activities could be verified in the southwestern and the southeastern regions. There banana production is ubiquitous and the surveyed groups have established informal, but dedicated relationships with buyers who they work with on a regular basis. 56 % of these buyers supply Uganda's capital Kampala. A minority of 7 % is exported to Rwanda. Banana bunch maturity and size were evaluated as the most important criteria for bunch price evaluation. Weighing is currently not practised, except when produce is exported to Rwanda. Accordingly, bunch evaluation and pricing is subject to negotiations among experts with respective tacit knowledge. Neutral price information systems often have entry barriers, they are for example cell phone based, and are mostly based on weights. Consequently they are little used, while information asymmetry and word of mouth communication prevail. A pan-Ugandan introduction of banana weighing could help improve marketing procedures. 96 % of the group members surveyed, 87 % of the non-group members and 74 % of the buyers think it would be good to weigh banana bunches. Critics among the farmers argue that through weighing new ways of beguilement in banana trade may be introduced. The possible manipulation of scales and cheating in the weighing process may cause severe problems they say. But the current total dependency on trust also hampers business transactions, while weighing is at least an option to reconfirm sensory estimations. Infrastructural problems, nutrient exports and input scarcity put severe strain on most banana production systems and weighing could provide for improvements by enabling farmers and their advisors to calculate estimations regarding the degree of biomass extraction from their agro-ecosystem and aid haulers and traffic planners in avoiding road damages. The benefits of weighing thus go notably beyond market organisation and fair price finding, potentially helping to recover and preserve the banana agro-ecosystems in Uganda which have over decades of intensive, unsustainable use been depleted.

Keywords: East African highland banana, grading, *Musa*, pricing

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Export Competitiveness of Gherkin in India

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Horticulture is an important component of agriculture accounting for a very significant share in the Indian economy. Rising consumer income and changing lifestyles are creating bigger markets for high-value horticultural products in India as well as throughout the world. Among these, the most important high-value export products are fruits and vegetables. With this background the present paper analyses the comparative advantage and competitiveness of gherkin (*Cucumis sativus*) which is one of the important foreign exchange earner among vegetable crops exported from India.
The primary data was collected from Tumkur and Bijapur district of Karnataka, India and secondary data was collected from concerned government institutions, APEDA and also from vegetable exporters. The Policy Analysis Matrix (PAM) was selected as the analytical tool to analyse the export competitiveness, comparative advantage, and the degree of government interventions in the production and export of gherkin. The policy distortions were measured through indicators of PAM. Garret ranking technique was used to analyse the constraints in the production and export of the selected crop.
Effective Protection Coefficient (EPC) of Gherkin (0.5) found to be less than one indicating that producers are not protected through policy interventions. Domestic Resource Cost (DRC) (0.27) and Private Cost Ratio (PCR) (0.43) values of Gherkin show positive social as well as private profit which indicates that, India has a competitive and comparative advantage in their production. The result for Garret ranking in case of gherkin shows that skilled labour and lack of superior quality are the major constraints in production and export of gherkin. The overall result shows that the cultivation as well as export of gherkin is economically profitable and efficient.

Keywords: DRC, EPC, gherkin, PAM

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To Sell or Not to Sell – Maasai Milk Marketing in Ngerengere, Tanzania

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In Maasai culture responsibilities and labour are divided between genders. In general, the livestock is owned and managed by men. Thus they control the main income source of the family. Women usually take care of the family and are in charge of milking the cows. They can also decide upon the use of the milk for home consumption or sale. For them, selling milk is the main possibility to earn their own income. Previous studies on Maasai household economy mostly focussed on the general aspects of diversifying income sources to secure family welfare and leave the potential economic contribution of milksales unclear. In this article we first propose an agricultural household model to fit the Maasai setting. Second, we use socio-economic clan- and household-data from the milk catchment area of a collection centre in Ngerengere, Tanzania, to assess the potential effect of selling milk on household income. We address self-selection bias and estimate the income effect by employing bivariate probit models and propensity score matching procedures. Our findings suggest that milk sellers earn significantly higher average incomes per capita compared to non-sellers. The results indicate that this is especially true for households selling milk not to the collection centre but to alternative market participants. These other buyers reach more remote areas, usually offer higher milk prices and are especially active in the dry season. However, they only purchase limited amounts of milk. The collection centre on the other hand is a guaranteed market with large purchasing capacity throughout the whole year.

Keywords: Bivariate probit, household model, Maasai, milk sales, propensity score matching, Tanzania

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Pastoralist Groups and the Management of Small-stock Marketing Projects in Marsabit County, Kenya

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The main economic activity undertaken in the Kenyan arid and semi-arid lands is pastoral production using local livestock breeds. The main species kept by Rendille and Gabra pastoralists include camels and small stock (sheep and goats). Small stock are considered as a source of ready cash for many pastoralist and they are the species first sold when pastoralist have a monetary need. Low access to markets is seen as a factor leading to low off-takes. This study sought to establish if creation of pastoralists' groups that allow for communal marketing activities could lead to enhanced livestock marketing. It's aim was to assess the feasibility and profitability of the pastoralists' groups engaging in livestock marketing. The study was conducted with two pastoral groups at the two locations of Malabot and Farakoren, both in the lowlands of Marsabit County. A sociological sample survey design was used using semi-structured questionnaires as the data collection tools. Data was collected on livestock off-take, returns from sale of livestock and benefits accruing to the group and individual group members. Twenty five group members and 200 community members were interviewed monthly over a one year period. The collected data was analysed using ANOVA, chi-square ($\chi 2$) and correlation analysis. Results indicate that the marketing activity was able to give good returns ranging from 15 % to 30 % return on investment. The activity also led to increased small-stock off-take rates from an average of 1 goat per household per year to between three and five with prices offered being rated as fair by a majority of community members when sold through the group. Individual group members benefitted by receiving money, livestock and employment. Issues to do with banking and disease spread by concentration of livestock were established as challenges of the group marketing approach in remote pastoralist areas. However overall, pastoralists' groups were found to be both feasibility and profitability and are recommended as an additional avenue to enhance livestock off-take in a pastoralist setting.

Keywords: Groups, marketing, pastoralist, small-stock

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Demand for Quantity versus Quality in Beef, Chicken and Fish Consumption in Nigeria

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A shift from quantity to quality especially when higher quality food becomes more affordable as income rise denoted change in consumer tastes and preferences. In an attempt to understand consumer behaviour with regard to how households respond to change in income vis-à-vis quantity and quality demand, the present study is designed to examine quantity and quality income elasticity in the demand for beef, chicken, and fish consumption in Nigeria. The analysis is based on cross-sectional data collected mid 2010 with the aid of a structured and pre-tested questionnaire from randomly selected 134 households in Ondo state Nigeria.

Using non-linear Engel's curve, the results revealed that as income increases an average household in the sample spend a higher amount on fish, followed by chicken and lastly beef. We found evidence that the demand for beef, chicken, and fish are inelastic and therefore considered as necessities among the sample households. The computed quality elasticities which is the difference between estimated expenditure and quantity-income elasticities, is positive for all three food items – an indication for an increased unit value of these food-items as the household income level increases. A significant policy implication from these findings is that the demand for quality beef, chicken, and fish increased in Nigeria. Hence, as a tool for planning, the outcome of this study will serve as a impetus for a better design of food, agricultural and trade policies with emphasis on food safety and certification to improve consumer welfare in the country. Besides, evident of demand for quality beef, chicken and fish will continue to be an important driver of demand for food, with the possibility of creating different marketing opportunities and increased welfare for Nigerians.

Keywords: Beef, chicken, elasticities, expenditure, fish, Nigeria

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Challenges and Prospects of Tracking Informal Cross Border Trade in Comesa Region

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This paper reviews the informal cross border trade (ICBT) in major staple food products among selected Common Market for Eastern and Southern Africa (COMESA) member countries. Current adopted approaches and methods of estimating informal trade are discussed and the magnitude of informal trade flows between countries are estimated. Few agencies in the region are monitoring the informal trade thus a lot of the data is unrecorded. The missing informal trade data leads to unreliable external trade statistics which might, in turn, affect effective formulation, implementation and monitoring of domestic and regional trade policies. If trade relationships among African countries have to be strengthened then it is essential to estimate real magnitude of informal cross border. Available informal trade data suggest that ICBT still represents a significant proportion of regional cross-border trade. Uganda Bureau of statistics (UBOS), for example notes that informal cross border activities have overall grown in the past 10 years among east and southern African (ESA) countries. In eastern Africa, Uganda's border monitoring survey, for example, indicates that in 2006, informal exports and imports flowing from Uganda to its neighbouring countries increased. The results also show that informal trade volumes and values for maize, rice, beans and pulses account for 36 and 37 % of total trade volumes and values in the region respectively. This paper concludes that the operations of ICBT as it is now in COMESA region are not effective to inform trade related decision making despite the high magnitude. There is need to enhance the ICBT monitoring activities through improvements in the quality of the informal trade data. Specific actions include increasing the number of border points monitored for informal trade as well as the need to identify borders with significant trade for monitoring. All the monitoring activities should take account of seasonal trade patterns. It is also essential to strengthen partnerships between the various agencies involved in trade monitoring by having regional collaboration of all the stakeholders in the ICBT activities. This will enhance efficient collection of adequate informal trade data.

Keywords: COMESA, informal trade, staple food

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The Emerging Livestock Feed Markets in East Africa: A Solution to Feed Shortages?

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Availability and access to feed resources is an important constraint to livestock productivity in East Africa. This study examined the production and marketing of livestock feeds in Kenya. The existing fodder value chains their constraints and opportunities are examined. A rapid appraisal survey was conducted with 93 actors along the value chain in November 2010. Findings showed that fodder marketing takes place at village and district levels. Trading at village level involved input sellers, producers who sold directly to rural retailers, rural consumers, or if they were near major district towns, to wholesalers. District level trading involved traders who sourced for fodder outside the district and retailed to wholesalers in major consumer markets within districts and to a lesser extend retailed in local areas. Service providers such as transporters and feed processors operated at all levels. Input providers comprised of agrovet and general retail shops while producers and consumers were mainly small and large scale farmers. Traders comprised of individual traders and cooperative societies. There are seasonal price variations and trading is common in the dry season. Fodder producers grow fodder for own use but sold excess often in the wet season. Few producers without livestock grow fodder for sale. Commonly traded feeds are Rhodes grass, maize stovers, oat straws and Lucerne hay and were preferred because they keep longer. Other forages are Napier grass and harvested roadside grass. Actors operated in uncoordinated manner. Cooperative societies played a key role in linking buyers and sellers, stimulating demand and providing credit. Input capital is perceived as a major constraint. Findings showed a need to promote feed marketing alongside feed conservation and feed processing as well creating platforms for linkages amongst actors. Market information is needed to enhance feed marketing systems.

Keywords: Feed, fodder, forage, maize, value chain

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Improving Market Demand and Productivity Level for an Underutilised Yam (*Dioscorea esculenta*) in Ghana: Implications for Crop Breeding and Production Choices

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Yam (*Dioscorea* spp.), especially *D. esculenta* locally called "oboedunum" is a high value commodity. But it is also a threatened species in Ghana, due to several factors including neglect on the part of science, technology, research and development – and, more importantly, their displacement by improved varieties, mining activities, bush fires, infrastructure development and over-grazing. Their full potential for income generation both through domestic markets and the export trade has not been realised due to neglect in production, handling and trading systems as a result of it poor sizes that inhibit its use for food and agriculture in Ghana.
The purpose of this study was to improve the size and market value of *D. esculenta* using different doses of radiation to promote the effective use of these species and enhance effective conservation and sustainable use for food, agriculture and industry. We observed through repeated experiments that irradiation of yam planting material at 40 Gy gave the best results producing a M1 generation with a decreased number of tubers but with an increased tuber size per vine. The weight of these tubers was on average 1 kg against 0.3 kg for the tubers of the control (unradiated planting material). Some characteristics are valued more than others, and prices vary across species, time, and market sites. Some residual symptoms of pest and disease damages on yam tubers reduce their market values. Tuber weight exhibits an increasing marginal value and price per kilogram increases above an optimum size; therefore, producers derive additional reward from extra-large tubers. We conclude that, to effectively access and benefit from urban markets, producers should focus on the improved size and conical shaped-tubers, which are easy to process and meet the aesthetic qualities preferred by urban consumers. The implications for research on improved variety development to reduce poverty and for crop and resource management practices are drawn.

Keywords: Breeding, demand, *Dioscorea esculentus*, Ghana, market, mutation, production, productivity, underutilised

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SWOT Analysis of Smallholder Livestock Production from the Perspective of Meat Consumers in Colombia and Nicaragua

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Global population growth, rising urbanisation, and income growth in developing countries lead to changes in peoples diets resulting in a rapidly increasing demand for meat. A higher demand on the one hand leads to opportunities for the livestock sector but on the other hand also puts stress on it. Environmental and public health issues force producers to adapt adequate production technologies and to guarantee a high product quality. This is an enormous challenge for smallholder livestock producers which are often lacking sufficient resources or knowledge and might limit their production capacity or market opportunities. In 2010, a semi-quantitative consumer study was conducted in Colombia and Nicaragua detecting consumer meat preferences, the state of knowledge about quality standards, and the attitude of the consumers towards smallholder livestock producers. Strengths, weaknesses, opportunities, and threats existing for smallholder livestock producers were identified. Results show that in both countries, meat price still is of major importance for consumers – meat quality is less considered but growing in importance. Thus, consumers mainly choose their meat supplier regarding meat price. Nevertheless, fear of diseases transmitted via meat consumption is prevalent. The level of knowledge about meat origin is low in both countries. Concerning the fulfilment of quality standards by distributors, consumers seem to be better informed – but results show that in many cases their information is wrong. Strengths and opportunities of smallholder production are amongst others cheaper product prices, the image of utilising natural feeds or higher connectivity with the consumer. Weaknesses and threats are for example low product quality, lack of transparency, insufficient formal quality control, or limited access to credit and training. Assisting smallholder producers to focus on the strengths and opportunities and to reduce the weaknesses and threats could help to satisfy consumer preferences and respond to new market opportunities.

Keywords: Consumer behaviour, consumer information, Latin America, smallholder livestock production

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Understanding the Marketing Chain of Citrus in the Valley of Caí, RS Brazil

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Fruit and vegetable sectors are seen as sectors in which small producers are able to participate due to their low demand on land and their high labour requirements. General objectives of this research consist of the economic analysis of the marketing chain adopted by different organisations and farmers in the productive chain of citrus. This research aims to contribute for the analysis and inquiry of the structure of governance adopted by cooperative, associations and producers individually in the citrus chain located in the Valley of Caí, RS, Brazil. The theoretical framework used in this paper is the Global Value Chain (GVC) theory. The results show that citrus farmers are well organised and adopt distinct marketing chain. For instance, an association, characterised by farmers without certification, trades its production to Sao Paulo through an intermediate who finally delivers it to big supermarkets and wholesalers. Second, a cooperative has a compostage plant offering organic inputs to its members. All members' production is organic and certified by Brazilian Biodynamic Institute (IDB) and FLO (Fair Trade Organisation). Besides, the cooperative has an agro-industry for processing and selecting citrus for trade in natura and processes juice designated either to domestic and international markets. Third, an association is formed by ecological and certified farmers. The association has a partnership with a cooperative which processes juice and jam trade to domestic retail. Around 10 % of total production is traded directly in local fairs having contact to the consumers. Finally, there are farmers who are not member to any cooperative or association. They trade their production basically in three ways in the domestic market: in local fairs, to fruit retail and to intermediates. It is concluded that the associations and the cooperatives are characterised by a modular value chain structure of governance where suppliers make the products according to the customers' specifications, detailed more or less by the former. The individual farmers are based on market governance. Market linkages can persist over time with repeated transactions - the cost of shifting the partner is low for both.

Keywords: Citrus chain, marketing channel, producers

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Estimating Consumer Preferences and Willingness to Pay for the Underutilised Indigenous Chicken Products

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Indigenous chicken serves many functions, which include the provision of meat and eggs for home consumption and income from sales. The purpose of this study was to estimate the consumers' responsiveness to a premium price and how much they were willing to pay for the indigenous chicken products in the market. The survey was conducted in three selected regions of Kenya. A total of 930 respondents were interviewed both in the urban and rural areas. Contingent valuation experiment was used in empirical data collection. The two-step Heckmann selection model was utilised to analyse consumers' decisions and the amount they were willing to pay. The study results revealed that consumers were willing to pay 23.3 % per kg more for indigenous chicken meat and 41.5 % for eggs. Socioeconomic factors like age, income, education and family size significantly determined consumers' willingness to pay for the chicken meat. Other important factors included the indigenous chicken meat substitutes' prices, attributes like taste/flavour, source and the product's form on purchase. The yolk colour and size of eggs significantly determined the respondents' willingness to pay for a premium price for eggs. Preferences for indigenous chicken products were found to be high. This information will assist in understanding both the urban and rural consumer's behaviour. Therefore, useful for the indigenous chicken producers, breeders, marketers and policy makers in developing efficient production and marketing strategies. This would also provide a means of improving food security and livelihoods especially in support of the rural poor indigenous chicken farmers.

Keywords: Contingent valuation, indigenous chicken, two-step Heckmann, willingness to pay

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Intensification of Crop-Livestock Farming Systems through Market-orientation in Ethiopia

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Increasing food production and sustainable management of the natural resource base are key global challenges facing our world today and will continue to be so in the future. This is primarily due to population growth, increased urbanisation and higher incomes. Ethiopia has a land area of about 1.2 million Km^2 and human population of about 80 million. The highlands, where integrated crop-livestock production systems dominate with varying intensities, occupy 35 % of the land and house 88 % of the human population and 74 % of the livestock resources. In the past, government support to subsistent production system with focus on cereal crops targeting household food security led to erosion-induced land degradation and plunged millions into poverty trap and food aid. In recent years, the Government of Ethiopia has taken a policy decision to transform subsistence mode of production into more market-oriented systems, and as a result the Improving Productivity and Market Succes (IPMS) project has been testing different options of knowledge management, capacity building and crop and livestock commodity development strategies in support of market-oriented agricultural development in 10 pilot districts in four Regional States. These districts are ecologically contrasting and represent production systems ranging from extensive pastoral to varying intensities of integrated crop-livestock systems. Systematic and step-wise approaches were employed to assess the production systems and implement various interventions in production technologies, input supply system, marketing and support services such as extension and credit. Technological interventions coupled with appropriate organisational and institutional arrangements are critical factors for successful and sustainable intensification of production systems through efficient use of resources (land, water, nutrient and labour). A shift in policy is required to ensure participatory decision making based on available resources, technological options and choices, functional input and output markets, efficient and effective service delivery and farmers capacity to respond to climatic and market changes and their capacity to produce, process and market products. This paper explains the IPMS approaches, methods and processes used for effective system integration and intensification. The lessons learned provide valuable information for scaling up to other areas with similar potential for market-oriented agricultural development.

Keywords: Crop-livestock systems, Ethiopia, intensification, market-orientation

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Collective Action for the Marketing of Mango in West Java, Indonesia

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Mango (*Mangifera indica*) has become a major importance to the incomes in Indonesia especially for the export market. However, low quality mango production is the main constraint to penetrate export market. Not merely for export market, the obstacles that may prohibit the attempt of producers to market their product are limited capital and lack of information on market requirements and prices. To overcome the barrier resulting from small size productions and limited resources, pooling resources and market products collectively in the form of community based organisation can be a solution to reduce high transaction cost and provide better access for mango growers. The study evaluates the external and internal factors that trigger the willingness to work together and motivation to act collectively to achieve visible collective benefits from market participations.

This research employs a qualitative approach through case study. The aim of this approach is to understand the coordinated behaviour for mango production and its supply chain through level of trust and reciprocity among individual group members. Interviews were conducted with 30 respondents representing the mango growers and rent-trees farmers in Cirebon, West Java as well as other stakeholders concerned.

The empirical work itself was conducted in the year of 2010 in Cirebon, West Java, Indonesia. The key findings are as follows: firstly, internal and external factors may induce the motivation of acting collectively. The dimensions of human and economic capital act as the boundary to internal factors whereas external intervention is the important aspect on external environment. Secondly, a patron vassal relationship remains vital; namely a leading role that attracts members to comply with good mango production practices and encourage members to access input market such as fertiliser and pesticide collectively. Thirdly, individual group members state that financial and technical supports are the reason to participate in group activities. Fourth, working together is the main reason to obtain price premium and incentives toward willingness to comply with standards set by external bodies (*e.g.* government, retailers, NGOs).

Keywords: Collective benefit, coordinated behaviour, Indonesia, mango

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Analysis of Dairy Value Chain: A Case Study of Dire Dawa City, Eastern Ethiopia

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The study was conducted to characterise the dairy value chain, to identify the actors involved and their roles, and to assess the challenges and opportunities for development of the dairy industry in Dire Dawa city, Eastern Ethiopia. A total of nineteen key informants (fifteen urban milk producers and four milk vendors) were interviewed using a structured questionnaire. In addition to the primary data generated through survey, secondary data were collected from various reports published about the study area and through consultation of concerned individuals and institutions. The results of the study indicated that the dairy value chain is not well organised in Dire Dawa. The roles and functions of all the actors in the value chain are not clear and there is a weak link between milk producers, traders and all stakeholders of the Dire Dawa dairy sector. The Dire Dawa dairy industry is constrained by various socio-economic, institutional, organisational and technical problems. Shortage and high cost of feed, lack of organisation that provides dairy related information, difficulty to get land, disease prevalence, lack of technical support, and lack of dairy related technologies are the major constraints related to milk production whereas problems related to milk marketing include lack of quality control of milk, lack of cooling and storage facilities at milk vending sites, poor quality of milk supplied from rural areas, sale of raw milk, inappropriate milk handling and storage vessels, and spoilage of milk due to lack of preservation and processing facilities. The major opportunities for the development of the dairy sector in Dire Dawa include high demand for milk, presence of enabling policy that encourages investment in the dairy sector, absence of competitors, and access to road, train and air transportation systems that gives easy market access to dairy products. Thus, in order to develop the dairy industry of Dire Dawa, all the challenges identified in this study need to be carefully considered and addressed. Moreover, possible intervention strategies should be designed and applied across the entire value chain in order to develop the Dire Dawa dairy industry.

Keywords: Challenges, dairy value chain, major actors, opportunities

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The Economics of Sheep Farming in Marginal Areas of Jordan and the Palestinian Territories

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The marginal areas in the Middle East region face harsh ecological conditions causing poor pastures and short grazing periods. Bedouin communities, living in these areas, practice livestock farming as major source of income for living. Sheep farmers were also confronted with high production cost due to increases in feed prices. The study aims to compare the economic performance of sheep farming in Jordan and the Palestinian Territories (PA) under these circumstances. Farm and market surveys were conducted for the season 2007/2008. Eighty three sheep keepers from Jordan (n=44) and the PA (n=39) were interviewed. Net Benefit (NB) from sheep farming was calculated for both regions. Non parametric Kruskal-Wallis test was applied to test the significant differences (at 5 % level). Sheep comprised more than 97 % and 71 % of the total flock size for Jordan and the PA respectively. Sheep flocks in Jordan were with 331 head significantly larger than in the PA (159 head) at $p = 0.001$. Net Benefit values including value of non-marketed production revealed that only sheep keepers in the PA generated positive values with 8.7 JOD and 862.7 JOD per ewe and per flock respectively compared to negative values in Jordan (1 Jordan Dinar ≈ 0.98 €). Only values of NB per ewe differed significantly ($p < 0.0001$) between Jordan and the PA. The proximity of sheep famers in the PA to the Negev and other sheep markets in Israel facilitate the process of procuring improved sheep breeds along with practicing fattening, as a step towards the intensification of production. Also the higher meat prices were fundamental reasons for better economic results in the PA.

Keywords: Jordan, marginal areas, net benefit, Palestinian territories, sheep farming

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Overview of Somaliland's Livestock Value Chain: Gender and Institutional Challenges of Women Livestock Traders

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Somaliland, a former British Protectorate is a self-declared independent government in the Horn of Africa that detached itself from Somalia in 1991. Its post-war economic growth is directly linked to livestock trade which is highest valued agricultural commodity in the country. The adverse effect of the prolonged period of war has led to the phenomenal increase of women involved in livestock trade. As a result, they have assumed greater economic responsibilities for the household to cope with the recent social conditions occurring in the country. This challenged specific gender roles in a society influenced by a lineage based system, the customary law and Islam.
To provide an overview on the participation of women in livestock trade, a case study in Hargeisa is undertaken since it is one of the biggest livestock market in the Horn and the seat of the self-proclaimed government. As a framework to structure the empirical research, value chain approach is used to identify the role of women actors and their relationships and interactions among other actors in the local livestock trade. In the value chain, women are dominantly involved in re-selling live animals, meat trade, and the processing and marketing of certain livestock products. Going deeply in the institutions and the rules of the game used in trade, the Institutional Analysis and Development Framework is used to understand the trading strategies of women actors in view of the current rules in the local market and considering the crucial aspect of intra-household relationships, in this sense the role of women that are, at the same time livestock traders and responsible for the household reproductive activities. This study affirms that women's trading behaviour is influenced by the existing institutions or the rules of the game used in trade as well as their community values. Existing formal and informal rules are insufficient to create horizontal cooperation and vertical coordination including other inefficiencies in the value chain. Thus women actors are not able to maximise the benefits gained from livestock trade including their ascribed attributes.

Keywords: Customary law, gender, Hargeisa, Horn of Africa, institutional analysis and development framework, institutions, Islam, lineage based society, livestock trade, Somalia, Somaliland, value chain, women

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The Intensification of Milk Production and the Quality of Dairy Marketing

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Dairy production has long been recognised for its potential to reduce poverty of small-holder mixed farmers. However, milk production can only generate income where dairy marketing institutions exist. Yet even where milk is sold, milk is often produced as very low levels of intensity, despite many attempts to increase animal productivity. On the other hand, one can find examples of intensified dairy production, often where the quality of milk marketing institutions is above average. However, few studies have attempted to gather data to specifically address the issue of how the quality of milk marketing is linked to the intensity level of milk production.

India, the world's biggest milk producer, and Ethiopia, home to the second-largest population of poor livestock keepers in sub-Saharan Africa, are suitable objects for such an investigation. They include areas where milk marketing is well established and the various forms of production intensification, mostly improving genetics and feeding, are widely accepted. On the other hand, large areas, often located in marginal regions, are hardly linked to dairy markets and milk is produced with only minimal yield-increasing inputs. However, most small-holder milk producers are situated in intermediate conditions with some opportunities to sell milk and using low levels of external inputs, such as concentrates.

In the present study, 176 group interviews in 90 villages selected according to the quality of their milk markets in three Indian states and two Ethiopian regions were conducted in conjunction with interviews of 76 milk buyers and 30 district key informants to collect data on production intensity and milk marketing.

The results indicate that although concentrate feeding and stall feeding increase with improved marketing quality, milk yields of the various dairy animal types (i.e. local cattle, cross-bred cattle, buffaloes) hardly vary. However, the proportion of cross-bred cattle being kept shows the greatest variation by marketing quality amongst all considered indicators.

Thus, it appears that improved dairy market opportunities allow households to invest in higher-grade dairy animals as the fastest approach to increase animal productivity. However, the question how dairy development stakeholders can maintain such productivity growth remains to be answered.

Keywords: Dairy marketing, Ethiopia, India, intensification, milk production

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Determinants for Chain Governance in Fresh Fruit and Vegetable Market: The Case of Northeast Brazil´s Grapes and Mangoes

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Considering topics relevant to developing countries involved in the market for Fresh Food and Vegetables (FFV) one has to consider different approaches available for grasping the content and dimension of social and economic processes triggered by the international integration of markets. The literature on Global Value Chains (GVCs) provide a set of concepts said to allow the idea of economic globalisation to be grasped"in terms of a series of relations organised around" commodities or goods. Analysts point out the fruitful advancements in methodology, theory and policy carried out by the literature in this field of study for the investigation of to which measure "commodity chains shape a country's development prospects". Amidst these advancements the concept of chain governance has divided the GVCs literature according to different affiliation to scholarly approaches on questions raised by the concept; mainly: how do coordinative arrangements over aspects of chains' activities are brought about in GVCs? Later developments in this literature turned to advancements offered by the french Convention School of Laurent Thévenot and Luc Boltanski among others. This perspective turns to a pragmatic notion of coordinative outcomes, giving prominence to the variety of standpoints by which social actors find support to solve momentous distortions of concerted actions. This stresses the moment of defining products and services' quality content as a seminal collective process offering the very substrate orienting the coordination of 'uncertainly grounded' business transactions.
Following these later insights this case study aimed to understand the process by which social actors involved in northeast Brazil's grapes and mangoes GVC to Europe mobilise arguments and legitimacy assetsïn the pursue of claim-grounding: how they bring forth fundamental sectoral claims for negotiation; how they propose compromises in the situation of ordering the coordination of uncertain transactions (existence of strong contests on quality perceptions); and the process by which the latter is conceived and conceptualised. For this, besides a few participant observations, semi-structured interviews with key-informants on different chain links were carried out. Results inform the strong relevance of the social-political structure mobilised by each actors' speeches for the strengthening and cohesion of coordinative arrangements.

Keywords: Conventions, global value chains, product quality, product service

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Livelihood strategies

Locating the Margin? Agriculture and Livelihoods Along the Rural-Urban Continuum of African mid-Sized Towns

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Subsistence and market agriculture typically play a significant role in the local livelihoods of rural people in sub-Saharan Africa. Increasing evidence also points to its importance to many urban and periurban households. Yet there is limited conception or understanding of how the relative contribution of agriculture to local livelihoods changes along dynamic urbanising gradients. Marked spatial and temporal changes in human population density, governance systems, land and resource tenure arrangements and other opportunities potentially change the relative contribution and significance of agriculture to local livelihoods. This paper reports results from studies of five mid-sized towns in four African countries, *viz.* Botswana, Cameroon, South Africa and Tanzania. In each town a standard questionnaire and GIS approach was used to assess various facets of agricultural production along a continuum from the centre of the town through the suburbs and periurban zones outwards into the surrounding rural areas. After capturing details regarding access to land, size, tenure and residency time, we assessed the prevalence of engagement in the production of staple crops, vegetables, fruits and livestock. This was complemented by indicators of the degree to which these activities contribute to household food security. The results indicate that the contribution of agriculture to local livelihoods is dynamic in space and time. Whilst there was the expected decrease in the importance of agriculture with increasing urbanisation, the results regarding prevalence were less predictable. At more nuanced levels there was high variability between towns, between locations along the rural-urban continuum, and even between households at specific points along the continuum. These results show that there are no distinct margins in space or time for agricultural activities in mid-sized sub-Saharan African towns, which in turn has important implications for town planning and land-use zonation, as well as local and larger scale programmes and policies to reduce livelihood vulnerability and land- /food insecurity.

Keywords: Food security, livelihoods, periurban, urbanisation

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Household Preference Heterogeneity for Organic and Fairtrade Yellow Chilli in Lima, Peru

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Certifying agricultural goods as organic and Fairtrade opens up two niche markets with potential benefits for both the environment and farmers in developing countries. Those certifications are expanding among farmers with access to external markets, but not among marginal farmers supplying internal markets in Peru. Those latter farmers state that national consumers are not willing to pay differential prices for certified products. In this research, we used a choice experiment to evaluate household marginal willingness to pay (mWTP) for three Organic and Fairtrade certification attributes: environmental protection, product without pesticides, and improvement in the quality of life of farmers. Yellow chilli was used as case study, because it is widely used for food preparation in Lima, Peru.

A face-to-face survey was conducted with 205 households. Each respondent answered two choice sets. Those choice sets included different combinations of organic and fair-trade attributes (indicated as present or absent) as well as five price levels (S/.6, 7, 8, 9, 10) plus the status quo, which was the current product without certifications with a base price of S/.5. The population sampling procedure was random and stratified by districts. The results were evaluated under homogeneous assumptions using a Conditional Logit (CL) model, and under heterogeneous assumptions using a Random Parameter Logit (RPL) model.

The RPL was preferred to the CL model based on the Bayesian Information Criterion estimates. This suggests that there is continuous preference heterogeneity across households. In addition, the standard deviations of Organic and Fairtrade attributes were statistically significant. This indicates that different households possess individual-specific parameters that are different from the sample population mean parameter estimates for those attributes.

The average mWTP were calculated from the individual-specific mWTP for Organic and Fairtrade attributes. The results suggest that households derive positive and significant values from both types of attributes, with a larger preference for yellow chilli cultivated without pesticides (S/.16.0, Peruvian Soles), and almost equal preference for environmental protection (S/.9.5) and improvements in farmer's quality of life (S/.9.3). Therefore, it is recommended that farmers advertise their yellow chillies as "cultivated free of pesticides" in Lima, Peru.

Keywords: *Capsicum*, marginal willingness to pay, Peru, random parameters model

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Accounting for Farmers' Risk Preferences in Modelling Land Use Decisions in Marginal Environments

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Real world decision-making entails an element of risk, which is particularly true for land use decisions by smallholder farmers in marginal environments. Consequently, an individual's level of risk aversion may be a crucial determinant of such decisions. However, in microeconometric models attempting to explain decision-making processes a measure of individuals' risk preferences is usually lacking. We address this shortcoming by testing the explanatory power of several hypothetical and non-hypothetical measures of risk preferences in an econometric model explaining land use decisions in a fragile upland area of Vietnam.

In the mountainous district of Yen Chau, maize has become the dominant cash crop accounting for 65 % of farmers' total cash income, on the average. Considerable output price fluctuations and adverse environmental effects in terms of soil erosion imply that this specialisation in maize production is a relatively risky livelihood strategy. Among others, the level of risk a farmer faces will depend on (1) the characteristics of the maize variety used and (2) the farm-level degree of specialisation on maize production. Hence, the objectives of this study are to investigate (1) determinants of farmers' choice between riskier and less risky maize varieties, and (2) determinants of the farm area share allocated to maize, accounting for farmers' risk preferences as an explanatory factor in both decisions. Based on data collected in a random sample of 300 households, we estimate a two-stage regression model, where a probit regression identifies determinants of variety choice, and a subsequent OLS regression identifies factors influencing area allocation, accounting for possible unobserved factors affecting both variety choice and area allocation. Whereas such unobserved factors commonly include the level of risk aversion, we test the explanatory power of different empirical measures of risk preferences in our model, in addition to other potential influencing factors related to farmers' resource endowment and market access. The measures include hypothetical choices about changing the household's sole income earning activity and selling an inheritance, self-assessment questions eliciting the level of risk aversion, a non-hypothetical measure based on Holt and Laury lottery-choice task decisions with actual payouts, and a factor analysis based index combining several measures.

Keywords: Econometric modelling, land use decisions, risk preferences, Vietnam

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Contingent Valuation Analysis of Rural Households' Willingness to Pay and Contribute Labor for Frankincense Forest Conservation

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Frankincense from *Boswellia papyrifera* forest (BPF) is a traded non-timber forest product (NTFP) used in pharmaceutical, food, cosmetic and chemical industries. It is widely used for rituals in different religions and as a fragrance during coffee ceremonies in Ethiopia. Moreover, the collection of frankincense is a source of income to rural people and the country gets foreign currency from exporting the product. However, in northeastern Africa the resource is under continuous degradation due to a number of human induced factors. The public good nature of the resource has contributed to the continuous degradation of the resource and has led to this 'the tragedy of the commons' and requires conservation measures. We used data from contingent valuation study with discrete choice responses to assess the factors influencing rural households' willingness to pay (WTP) and willingness to contribute labour (WTCL) for BPF conservation in Ethiopia. We relied on different regression techniques to estimate households' WTP and WTCL. We found household income, education and gender as the most important factors affecting WTP whereas household income and household size as the most important factors affecting WTCL. Households are willing to pay at least US$ 4.97 per year or contribute 7.18 labour days for the conservation of BFP and this amount does not differ between users and non-users of BPF. Therefore, this study indicated that, people are willing to contribute for conservation of the resource despite the fact that Ethiopia is a low-income country. Moreover, the study also indicated that free labour contributions can be used to estimate the valuation of non-market benefits of environmental amenities of income constrained rural households in developing countries.

Keywords: *Boswellia papyrifera*, conservation, contingent valuation, willingness to pay

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Impact of Coffee Certification on Small-Scale Producers: A Case Study in Jimma Zone of Ethiopia

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Given the fact that small-scale coffee producers in Ethiopia have a very low level of asset base and thereby are vulnerable to a vicious circle of poverty, certification is argued to be a recommended strategy to provide such impoverished farmers, access to a market channel that entails higher income. Against this backdrop, this paper sought to address the following question: To what extent participation of small-scale coffee farmers in certified supply chain does improve the former's socio-economic position? Household data has been collected on a sample of 249 coffee farmers in the Jimma region of Southwestern Ethiopia during September and November 2009. The empirical strategy followed for impact evaluation in the paper is to estimate the treatment effects against the counterfactual. Both regression methods and propensity score matching have been used for impact estimation and qualitative information from focus group discussions have been supplemented to explain the empirical findings. Findings show that certification has a low impact on small-scale coffee producers' livelihood mainly due to (1) significant price effect, (2) low productivity, and (3) limited support from cooperatives. The study also reveals that the coffee cooperatives suffer from acute infrastructural deficiency that limits their ability to integrate the member farmers into certified supply chain. The paper concludes that certification alone is less likely to bring significant poverty alleviation to the coffee farmers in Ethiopian coffee cooperatives. In the long term, more focus is needed to increase the technical, financial and human capacities of the local coffee cooperatives to make them more effective partners in the value chain – before or even instead of certification.

Keywords: Coffee certification, cooperative, Ethiopia, poverty reduction

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Impact of Laws and Regulations on the Use of Non-wood Forest Products in Central Africa

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The Congo Basin is home of some 100 millions habitants of which the livelihoods of many depend on the forest providing a huge number of non-wood forest products (NWFP). NWFP contribute to household food security, help to generate employment and additional income and offer opportunities for small and medium scale enterprises involved in harvest, transformation and trade of these products. This paper explores the impact of laws and regulations governing the use of NWFP on the wellbeing of forest dependent communities and the promotion of small- and medium scale forest based enterprises (SME) in Central Africa. Exploitation of NWFP is regulated by national forest legislations which generally distinguish between subsistence and commercial use. Local communities enjoy access to NWFP through their traditional user rights which are recognised by modern forestry laws but limited to subsistence purposes. The small-scale commercial use of NWFP is excluded by these user rights, although local communities especially women, children and indigenous people regularly trade small quantities of NWFP allowing them to purchase food, medicine, clothes, kitchenware and to pay school fees. Commercial trade and processing of NWFP are subject to regulatory and legal frameworks which are focused on the timber value chain and not adapted to the realities of SME based on NWFP. Traders need to obtain professional licences and exploitation permits from the centralised administration and way bills from decentralised offices in charge of forests; administrative processes that often hinder small- and medium scale traders to legalise their entrepreneurial status. Both, legal and illegal traders are subjected to illegitimate payments at numerous roadblocks by police and forestry officials creating high transaction costs. The different national tax systems are not harmonised within the region; quotas for exploitation of NWFP are allocated without knowledge of the resource base and do not enforce the sustainable use of endangered species. Since 2005, the Central African Forests Commission (COMIFAC), governments and partners like the Food and Agriculture Organisation of the United Nations (FAO) are working on the improvement and harmonisation of legal and regulatory frameworks in order to enhance the contribution of NWFP to the wellbeing of local communities.

Keywords: Central Africa, illegitimate payments, legal framework, non-wood forest products, user rights

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When Eco-agriculture Loses its 'eco' - Determinants of Conversion of Shade Coffee among Smallholders

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As the global agricultural estate expands at the expense of forested areas the ability of agricultural landscapes to provide environmental services increases in importance. Understanding the determinants of land use change is necessary in order to manage trees and forested areas in agricultural landscapes that are essential for the provision of many environmental services. Shade coffee production, an widespread agroforestry practice among smallholders in the developing world, is an important source of trees in agricultural landscapes. This study assesses the loss of shade coffee from 2000 to 2009 in a Costa Rican biological corridor, an example of an ecoagriculture landscape, and investigates the household level determinants of land use change. In order to determine the effect of farm and household characteristics on future land use change, an ordered probit model is applied to household and land use data for the years 2000 and 2009, collected in 2009 among 217 former and present coffee farmers. Additional 224 telephone interviews supplement the data on changes in the coffee area. The results show a reduction in the coffee area from 903 ha to 461 ha during the study period, and an estimated loss of 40,000 shade trees from the 441 participating households. Family labour, use of shade tree products, farm gate coffee prices, and age of household head significantly reduce the probability of converting the coffee farm, while number of family members engaged in other agriculture and non-farm work increase the probability. Supported by qualitative information from key informant and farmer interviews, the results point towards a process of deagrarianisation, where labour intensive farming is reduced in favour of other land uses and non-farm activities. Households with stronger ties to coffee farming are found to be less influenced by this process. The national programme for payments for environmental services has yet to reach coffee farmers in the biological corridor. Meanwhile, the ongoing land use change may have serious implications on the habitat connectivity as well as on other environmental services. Joint efforts of local researchers, NGOs and GOs to promote a new payment scheme directed at coffee agroforests may counter this development.

Keywords: Costa Rica, ecoagriculture, land use change, Probit model, shade coffee

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Farmer's Satisfaction about Crop Insurance: Case of Southern Iran

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Rural household income in developing countries can fluctuate widely and can face enormous risks. Farming in particular is one of the world most tension-filled occupations. Sources of stress to farm families include financial, social, as well as weather related dimensions. Regarding the latter, farmers, throughout history, have been required to make decisions under uncertainty and use different coping strategies for survival. While they cannot prevent extreme meteorological hazard events, such as drought due to lack of precipitation, there are instruments which can mitigate losses. In that regard, crop insurance is one of the most important instruments from a (financial) risk management perspective. This is an innovation in rural areas that the best way for diffusion it between farmers is congruence it with farmers' need and wants. The purpose of this study was to identify the major determinants of satisfaction among insured farmers. The study was conducted in the three provinces of Iran which located in the south of Iran. Survey research and multi sectional sampling procedures were used to select farmers. The final sample consisted of 570 farmers. The sample consisted of two groups of farmers: 1) currently insured, 2) used to be insured. Besides a literature review for designing the questionnaire, a pre-pilot study, field observation and in-depth interviews with farmers were performed to develop the questionnaire for collection of the main data for this study. In designing the questionnaire, a 5-point Likert scale (strongly disagree to strongly agree) was used to reduce the statistical problem of extreme skewness. The validity of the questionnaire was approved by a panel of experts. Furthermore, it was field-tested in a pilot study that included 40 farmers from Bushehr province. Additionally, Cronbach alpha assessment were used to refine the questions for the final questionnaire. Results revealed for currently insured, corporate image and service quality for used to be insured, farmer's commitment and service quality and for all farmers, corporate image, service quality and reparation have direct affect on farmer satisfaction. Finally we have some suggestion for more farmer's satisfaction about crop insurance that will made more adoption crop insurance by farmers.

Keywords: Crop insurance, South Iran, satisfaction

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Factors Determining Behaviour of Thai Households in Adopting Geographical Indication Certification for Jasmine Rice

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Geographical indications (GIs) as a tool to promote socio-economic livelihoods of rural communities have gained more interest among policy makers and in academia alike since its protection has been ensured multilaterally under the Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement of the World Trade Organisation (WTO). Thung Kula Rong-Hai Thai Hom Mali Rice (TKR) being traditionally produced in the Thung Kula Rong-Hai(TKRH) region in the Northeast of Thailand is considered as the first registered GI rice. A GI certification is licensed to producers and other business operators of the GI production line through a membership application in a GI-Club. It provides protection to its producers against any counterfeiting by parties other than the genuine producers. This paper aims to identify factors that are likely to predict the behaviour of Jasmine rice households in the TKRH area in adopting a GI certification and to estimate marginal effects of key factors on the probability of adoption. Base on a primary data of 370 households, the empirical analysis follows a two-step approach – first, logit models are used to find the key determinants for GI adoption and finally, the marginal effects of these key factors are estimated to show the relative strength of the determinants. A major finding of this study stresses the importance of institutional and social factors, *i.e.* access to information and membership of a cooperative which mostly determine the probability of GI certification adoption by Jasmine rice households in the TKRH area. The price premium seems also essential in compensating transportation costs associated with the GI certification adoption and in guaranteeing the net benefit of being GI farmers. Thus, successful introduction and promotion of a GI system depends particularly on the information provided to farmers and on the information sources. Strengthening the role of organisations such as cooperatives which serve as a crucial intermediary between a primary source of information about GI, *i.e.* government and farmers may therefore promote the effectiveness of information dissemination. Better access to points of sale for certified GI households should be also provided in order to increase the farmers' incentives to adopt GI certification.

Keywords: Certification, geographical indications, Jasmine rice, Logit Model, Thailand

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Efficiency of Market Based Instruments for Protecting Wetlands

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Wetland management is connected with a number of important issues such as food security, biodi-versity, water scarcity, tourism and climate change. Hence, the increasing exploitation, degradation and loss of wetlands have given cause for worldwide concern. Many of the problems stem from large externalities caused by the use of ecosystem services. To alleviate external effects, economists tout many market-based systems as a remedy. However, not all market-based systems are applicable under all circumstances, especially since ecosystems services are heavily interlinked: for instance, if property rights for a forest area are distributed with the purpose of bolstering tourism attracted by forest ecosystem services, it might help preventing forest degradation and loss. Yet, it may also have adverse effects on wood extraction or conversion of forest land into agricultural land, which might be well warranted. The overwhelming complexity and dynamics of an ecosystem demands a system of managerial institutions that can set the right incentives for all stakeholders to promote efficiency and still disentangle the relationships in a manageable fashion. Prime examples and methods often practised are certification and mitigation trading of ecosystem services.

This paper tries to find a recommended set of market-based systems to approach the problems circumscribed above. Using the example of agriculture and aquaculture, the paper analyses appropriate existing and possible market-based instruments, their applicability and their shortcomings. The findings suggest that the considered instruments have potential to increase welfare also within the context of wetlands. However, the strong interdependencies between different ecosystem services may limit their scope of impact. For example, targeted subsidies and product certification may be attractive given the (relatively) low requirements in terms of system infrastructure and monitoring, but fail to incorporate spill-over effects on other production activities.

Keywords: Ecosystem service, institutions, market-based instruments, wetland

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Organic Banana from Selva Central in Peru: Constraints for Smallholder Profits and Options for Upgrading

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Bananas and plantains are an important part of the diet in Peru. About 150000 households depend directly or indirectly on these crops. Small holders produce a large share of bananas for domestic markets in low-input coffee and cocoa agroforestry systems.The weekly to monthly sale of banana contributes to maintain the household between the annual harvests of cocoa or coffee. This study aims at characterising the value chain for agroforestry bananas and analysing factors that influence profits. Possible upgrading strategies to increase producers' income were identified. Surveys and expert interviews were conducted in a major producing region (Junin, Central Selva) and major market places in Lima between August and October in 2010. Two main chains were identified — a local chain to retailers in Junin, and a longer distance value chain to Lima. Results show that in the long distance chain, farm gate prices ranged from 0.50 to 0.65 PEN per kg, while in the local chain, prices were about 0.10 PEN lower. Prices as well as costs varied among households. Results from regression analysis showed that farm gate prices decrease with poor road infrastructure and a smaller number of buyers visiting the communities. A long-term relationship between farmer and buyer results in lower prices, since farmers trade-off prices for secure demand. Higher prices are obtained by better-off producers and those who are paid immediately. For upgrading, horizontal coordination among farmers could compensate for these limitations by negotiating immediate payments, by decreasing dependency on few buyers and by lobbying for support to improve road infrastructure. Possible new buyers were identified, including supermarkets, which signalled their willingness to buy directly from farmers, conditional on improved fruit quality and guaranteed minimum quantities. Potential buyers in Lima are organic markets, which would allow growers to capitalize on their organic coffee certification. A third option is based on diversification of varieties, for which some demand in Lima could be identified, or the labelling of bananas based on environmental benefits of the production system. All these options require improvements in the production system, post harvest handling as well as in farmer group marketing capacity.

Keywords: Agroforestry systems, bananas, upgrading, value chain analysis

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Sustaining Livelihoods Around Community Forests in Cameroon. What Is the Potential Contribution of Wildlife Domestication?

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Community forest management is generally accepted as a new and more appropriate solution for the failure of top-down approaches to conservation in forest communities. Based on basic relationships outlined in the property rights theory, it is recognised that local communities must have direct control over the utilisation and benefits of forest resources and would value the need to appropriate resource units in a sustainable manner. Thus community based forest management should enhance both conservation and sustainable livelihoods especially for communities living at the margins of such forests. Though this is generally accepted by pro-community scholars, sufficient empirical evidence does not exist that provides information on intra-community dynamics with regard to existing differences in perceptions, conservation practices and livelihoods between households who are directly involved in the forest management institutions and those who or are not. Governance concepts underlying community forest management may vary and account for empirical differences.

This paper comparatively analyses the socio-cultural, economic and institutional situation and wildlife consumption and domestication patterns for a random sample of 200 households from six forest-adjacent communities in two divisions covered by the Kilum-Ijim Mountain Forest of North West Cameroon. We assume *a priori* that if FMI-participants are significantly better-off in terms of livelihoods, this will be a clear indication of the pursuit of self-interest, manifested in the legal and illegal appropriation of resource units for own consumption.

The socioeconomic analysis reveals that FMI-participating households are generally better-off than the matching households. Available wildlife monitoring data demonstrated a mixed evolution of wildlife species, with the complete disappearance of some species in the community forest and in-migration by new species. The consumption of wildlife (bushmeat) per capita was however very low, even if it was slightly higher for FMI-participating households. Perceptions towards the Giant cane rat domestication, a highly favoured bushmeat that is suitable for domestication, were high for both household types.

The paper concludes with the potentials of wildlife domestication, particularly the Giant cane rat for livelihood improvements and wildlife conservation.

Keywords: Cameroon, community forests, Kilum/Ijim, livelihoods, wildlife domestication

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Why Small Producers Do Not Participate in Organic Certified Agriculture? – The Case of Cocoa in the Brazilian and Peruvian Amazon

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Today, it is widely believed that market tools, such as organic certification and/or other incentive payments can help improve the conditions of the global commons. For example, in the Amazon region, incentive payments are assumed to have the potential to positively impact forest conservation while also improving the social conditions of the people who provide these goods. This study aims to provide insights into smallholders's attitudes towards participation in organic certification schemes in the Brazilian and Peruvian Amazon. An analytical framework on the conditions affecting participation was built based on rational choice and collective action theories focusing mainly on individuals' rationality to cooperate. The analytical framework was then applied to colonist farmers on study sites along the Transamazon Highway in Pará state, Brazil and at the Federico Basadres Highway in Perú. Direct observation and unstructured interviews were used with informants stratified into three groups according to their participation status in organic certification: current participant, past participant and non-participant. In addition, semi-structured interviews were conducted with local technicians to retrieve their perceptions about farmers' answers on certification. Preliminary results show that several economic and non-economic conditions affect smallholder participation, with an emphasis on availability of other local commercialisation opportunities better suited to conditions already met by smallholders; technological incompatibility between certification parameters and local capacities (further aggravated by economic stratification among producers); lack of trust in cooperatives (also related to wealth heterogeneity); and inflexibility regarding individual operations due to imposition of organic certification rules (rather than unwillingness to cooperate). Many of these challenges are related to: 1) The lack of a clear governance structure that supports smallholders' ability to make their own decisions on their livelihoods and 2) The lack of social organisations that target livelihood benefits for the entire social group. As a result, several farmers cannot afford to be certified. Overall, the Brazilian case showed that gender perspectives, wealth heterogeneity and expected benefits need to be better understood.

Keywords: Certification, collective action, conditions, governance, participation, rational choice

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Standards and Contracts between Small-Scale Pineapple Farmers and Exporters in the Huetar Norte Region of Costa Rica

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Nowadays global agricultural markets are experiencing an increase in the concentration of the retail sector and in the importance and complexity of standards. These two trends are causing developing countries to modify their farming systems, switching from sport market transactions to vertical coordination in order to access high value supply chains and fulfil volume and quality requirements.

The present study evaluates the relationships that arise between small pineapple produc-ers and exporters in Costa Rica and the factors influencing contract and standard adoption. Research data was collected on 173 households in the Huetar Norte region of the country, where most of the small producers are located. The surveyed farmers trade with the exporters under signed contracts or verbal agreements and hold process standard certification, mainly GlobalGAP and RFA. A control group of farmers who trade without a prior agreement and have no standard certification was also interviewed.

A picture of the sector and the risks farmers face when entering in a cash crop production system is described. An ANOVA or non-parametric test analysis was done to find out the differences on the characteristics of households engaging in vertical coordination and the characteristics of the contractual relationships and a probit analysis was carried out to determine to which extent different factors influence standard adoption. Finally a factor analysis was done to identify farmers trust and loyalty towards the firm they con-tract with, and their attitude towards standard certification, factors that may influence the sustainability of the value chain. The results show that vertical coordination is linked to standard certification and that there are statistical significant differences in terms of farmers and relationship characteristics when comparing signed contracts, verbal agree-ments and no agreement. Trust an loyalty towards the firm vary among the sampled farmers.

Keywords: Attitudes, contracts, Costa Rica, pineapple, small-scale farmers, standards, value chain

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The Effect of Conservation Policies on Farm Labor Allocation Decision among Crop Livestock Farmers in Bhutan: A Household Modelling Approach

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About 80 % of the population in Bhutan are concentrated in the rural areas and most farmers practice crop and livestock integrated farming system as a means to sustain their livelihoods. The country imports about more than 70% of its food requirements and internal production is constraint by huge challenges relating to factors like land degradation, soil fertility issues, economic factors like high cost of inputs, low market prices. Bhutan is lauded for its strict nature conservation policies wherein the country has been able to maintain 72 % of the land area as natural forests and preserving a wide variety of plant and animal species. The country is one among the ten Biodiversity hotspots in the world. Such policies also generate negative externalities and the more recent problems that are arising are the conflict between wildlife and the farming communities. The strict rules prevent the farmers from doing any harm to the wild life species. The farmers spend a considerable amount of their productive time guarding their fields against wild animals. Some skeptics also point out that the farmers are paying a huge price for conservation. Therefore, the objectives of this study were to study the farm household?s decision making in labor allocation and the decisions of the farmers in response to changes in some conservation policy scenarios.
The data for this study was collected in 2009 in Bhutan. The primary data was collected through a purposive stratified random sampling method among 292 households from three sub districts in Bhutan. The secondary data was used from FAO, Agristat, 2009.
The methodological part consists of using a non separable household model with an objective function to maximize the utility gained by the households from the consumption of own produced food, market purchased goods including food, education, health, etc and leisure subjected some constraints which are identified as maximum available resources like land, labor and income. The production and consumption parameters were calculated using a Cobb Douglas factor share method which are used in a non linear programming model to analyse the decision making of the farmers. The model is solved by using General Algebraic Modelling System (GAMS).

Keywords: Agriculture policy analysis, crop and livestock farming system, household model

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Economic Analysis of Certification in the Organic Citrus Fruit Chain in Brazil: A Case Study of a Cooperative

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Fruit and vegetable sectors are seen as sectors where small producers are able to participate due to their low demand on land and their high labour requirements. However, the concern is that small producers' participation in the international fruit and vegetable trade could be diminishing as a result of the increasing prevalence of food quality standards in the sector. General objectives of this research consist of the economic analysis of the certification in the productive chain of citrus. The theoretical framework used in this paper is the Global Value Chain (GVC) theory. This research aims to contribute for the analysis and inquiry of the occurred institutional changes in the citrus chain of the ECOCITRUS cooperative, located in the Valley of Caí, RS, Brazil (between producers, associations or cooperatives and purchasers) derived of the adoption of the certification in terms of transaction costs, contractual relations, structures of governance, value aggregation and upgrading. Inside of this perspective, it is contributed to infer the determinative aspects which take the producers to adopt certification programs. Cooperative ECOCITRUS have 110 associates, each, on average, with 12 to 15 ha of total area. General speaking, 60 % of the total area is orchard. It composes the cooperative, the headquarters, agro-industry for the processing of the fruits and the plant of composting, where 5 000 m^3 of residues are processed monthly. The creation of the plant appeared from the demand for organic raw material for the citrus production. All inputs used by the associates are organic. Organic standards have long been used to create an agreement within organic agriculture about what an "organic" claim on a product means, and to some extent, to inform consumers about it. It is distinguished that the cooperative not sells nor purchase fruits of third parties. For the majority of the associates, the income obtained from the citrus represents the income most important. The production is based on the culture of orange and tangerine. Of the sum of 2 000 produced tons, 40 % are processed the juice (exported for the Europe) and of 60 % remains, effected sold without processing (domestic market).

Keywords: Certification, citrus, organic, smallholders

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Factors Determining Farmer Satisfaction with the Organic Certification Process in Chile

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Certification schemes currently play a key role as quality assurance instruments in the food industry. This is particularly important in organic production, as this is a process-oriented attribute that can not be verified at the end product level, and inspections normally carried out by independent bodies (third -party certification) are required to control for fraud in the whole organic supply chain. Farmers may benefit from the use of organic certification, especially those from developing countries, but also perceive negative effects of adopting such a scheme. In other words, organic certification may not always meet farmers' expectation with detrimental consequences on farmers' satisfaction. Dissatisfaction with the organic certification system may encourage farmers to change the current certification body or shift to conventional agricultural practices with implications for the private and public sector. Under these circumstances it seems to be reasonable to assess the farmers' satisfaction with the certification system. Therefore, we develop and analyse a structural equation model using data collected through face to face interviews in the Ñuble and Curicó provinces of Chile. In total, 60 organic farmers were surveyed on their perceptions about organic certification. The findings show that the majority of the organic farmers are satisfied with the organic certification. We also observe that the perceived benefit in terms of farm income has a positive effect on and is a significant predictor of farmers' satisfaction. As we expected, bureaucratic aspects influence significantly and negatively farmers' satisfaction, which indicates the need to simplify the bureaucratic procedure to obtain the organic certification approval. Surprisingly, the perceived reliability of the organic certification has no significant impact on satisfaction. In the same way, neither the reputation of the inspector nor the certification body determine the perceived reliability of the organic control scheme. In this case, external sources of monitoring and the perceived risk in the organic sector play a major role. Based on the results of this study we develop recommendations for the public and private sector.

Keywords: Certification, organic farming, partial least squares

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Free Trade - Fair Trade - Aid: Impact on Sustainability and Vulnerability

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The reduction of poverty is one of the United Nations millennium goals. Fair Trade, aid and free trade are more (Fair Trade and aid) or less (free trade) intervention strategies with the goal of decreasing poverty and improving living standards of people. The values behind the concepts, the topics taken into account (sustainability of nature, en-vironmental issues, societal aspects etc.) and the implementation are different: Fair trade as originally North-South movement strengthens market failures and seeks to implement long-term business relationships, special pricing mechanisms etc. whereas the central ob-jective of today's aid programmes is poverty reduction. Because fair trade seeks to improve the exist-ing trading system and has at the same time many characteristics of a development project we can state that fair trade stands between free trade and donations. Within the last two decades free trade has been an important element of policy advice to developing countries. At the same time, there is an ongoing debate whether aid or free trade is the best way to decrease poverty and increase welfare.

Donations from private people, aid from governments or NGOs as well as the kind of trad-ing system have various purposes, reasons and impacts on *e.g.* child labour, education, health, family income, long term business relationships, the cultivation system; but they are especially different with respect to vulnerability and sustainability of livelihoods, two issues hardly discussed by the field.

The aim of this paper is therefore to analyse of the potential of three concepts with regard to their ability to address sustainability and vulnerability issues.

Keywords: Aid, fair trade, free trade, sustainability, vulnerability

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Marginality: Adressing the Root Causes of Extreme Poverty

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Global development patterns have changed. The majority of poor today live at the margin in countries which have become richer, but failed to redistribute their wealth. The remaining persist in low income countries and the number of undernourished remains too high to achieve the MDG no.1. Against this background, identifying and reaching the marginalised poor with measures which are adjusted to their needs and aspirations and consider the complexities of their lives, becomes a non-trivial task, which requires a post-normal conceptual and analytical approach. Based on systems thinking, a conceptual and analytical framework is developed in this paper, which generates a deeper understanding of the causal complexes of marginality which hinder the poorest from advancing out of poverty. The frameworks developed are the basis for designing tailor-made intervention packages and dynamic models for marginality. The conceptual frame developed here, views marginality as a root cause of extreme poverty. Causal complexes tie the marginalised poor in systems from which they want to escape or in which they want to improve their lives. The poorest themselves have described their situation as being trapped in a "complex knot which can lead to further knots if the wrong threads are pulled." While poverty is objectively a matter of absolute deficiencies, we explain why the way in which poverty is perceived by the poor themselves, requires looking at poverty as a relative, subjective, dynamic and systemic phenomena. Patterns of marginality are described as causal complexes in societal and spatial dimensions at the margin of social, economic and ecological systems. These causal complexes can be different types of livelihood systems or different types of poverty traps. They include proximate as well as underlying causes of extreme poverty and specifically address social exclusion and restrained access to assets and opportunities.

Keywords: Causality, complexity, extreme poverty, marginality

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Afghan Migrants Working in Iran's Agricultural Sector: Impacts on the Livelihood Security of their Families Left Behind Case Study Tehran

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Despite the massive repatriation of Afghan migrants conducted by the Iranian government and the OIM, the recent census data states that there are nearly 920,000 Afghans still remaining in Iran holding a refugee status. Nowadays, the magnitude of the human displacement in Afghanistan has placed to this country with the second largest refugee population in the world. This mobility is a key livelihood strategy for Afghan families and it may be seen as an economic contribution for reconstruction and temporal stability of the country through remittances sent by Afghans living in Iran.
The aim of this study is to show the importance of remittances earned with toil and trouble by Afghan migrants, as well as it is for their families left back in their homeland. These remittances are broken down to gain a wide viewpoint of the economic situation of the Afghan labour force in Iran, a case study: Tehran. The data collected denotes the relation among remittances and household size, remitters, time living in Iran, migratory status, age, as well as to briefly demonstrate the main use of remittances by the recipient families in order to cope with the unleashed poverty in Afghanistan. In the other hand it point outs the harsh situation that Afghan migrants have to deal daily to remain in Iran although the government have strongly decided to repatriate all Afghan migrants living in Iranian ground and to implement a better control of the labour market. The Iranian government argues that Afghan migrants in the short and long term are weighting down the economic development of Iran, and even they have caused underdevelopment for Iran's agricultural sector by the existence of an Afghani army labour force offering constant cheap manpower.

Keywords: Afghan labour force, Afghan migrants, Afghan refugees, agricultural sector of Iran, remittances

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Community Forestry in Nepal: Addressing Livelihoods of the Poor

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The community forestry (CF) programme was formally launched in Nepal in 1978. Following three decades of implementation, it has been globally recognised as one of the progressive models for participatory forest management. At present, about one-third of the country's population have been involved in the CF programme directly managing around 25 % of the national forest through more than 14 000 forest user groups (FUGs).

Beyond its initial goal of forest protection and supply of forest products for subsistence, the CF programme now has been progressively shifted into the issues of good governance, livelihood promotion, sustainable forest management and environmental services at local and national levels.

The FUGs' sensitiveness, decisions and activities in the favour of their poor members are the pivotal issues in CF program. This study, conducted in 2008, explores how these aspects are addressed in FUGs. It depicts an analysis of 309 FUGs of mid hills of Nepal. Different participatory tools and semi-structured interviews were used for the qualitative and quantitative data collection.

The study revealed that significant efforts were made by the FUGs to support the livelihoods of poor members of the communities. Altogether 87 % FUGs had identified poorest households in their groups of which more than two third had already put poor friendly provisions in their forest management plans and were implementing the activities accordingly. The activities included equitable distribution of forest products with positive discrimination to the poorest households (57 %), representing the poor in leadership positions (61 %), providing scholarship to the poor households' children (13 %), employing them in forestry activities (19 %), providing community land for forest based income generation activities (20 %), prioritising them for skill based trainings (34 %), allocating community fund for their income generation (41 %), added with the support to the disaster victimized poor for housing and health services (22 %).

These FUGs were found successful in addressing the livelihoods enhancement issues of their poor members' in the rural communities. Thus, CF programme could be a vehicle to drive the poor communities out of the poverty line through the sustainable management of local forest resources.

Keywords: Community forestry, livelihoods, poor

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Managing Forest Wildlife for Human Livelihoods: A Multi-agent Systems Model to Assess Socio-economic and Ecological Sustainability

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Bushmeat consumption, the consumption of meat from wild forest animals, is an important part of livelihoods in rural West- and Central Africa. Based on extraction-production models it has been suggested that in the Congo Basin bushmeat protein supply would drop by 81 % by 2050 in a 'no-change' scenario of current extraction levels. In order to secure this resource for the future, sustainable harvesting in community-based wildlife management (CWM) approaches is a potential option, aiming at maintaining the recommended daily protein allowance (RDA of 52 g per person per day, FAO). However, the social, economic and ecological sustainability of forest wildlife management has rarely been investigated in a holistic approach.

The poster presents the approach of an international and interdisciplinary African-German research team to assess conditions under which CWM can be made socio-economically and ecologically sustainable. In a multi-agent system (MAS) approach, we study principal actors (or 'agents': *e.g.* hunters, traders, wildlife), their characteristics and their relationships and simulate effects of different approaches to manage wildlife, in particular populations of two species of small- and medium-sized antelopes ('duikers' *Cephalophus* spp.)on household economy. Data are being gathered for an 'artificial' model landscape of the Korup / Oban Hills region (CMR and NGR) on site, and aims at simulating a realistic picture of the current system in this and other, similar regions. We use the CORMAS platform, which serves as main tool both for scientific analysis and for companion modelling in negotiations with stakeholders. The project is composed of five subprojects and has a strong research capacity building component: during 2008–2011 it supported four PhD, nine Master level (including two Diploma, six M.Sc., one M.A.), nine Forest Engineer (Diplome d'Ingenieur des Eaux et Forêts) and an uncounted number of B.Sc. level students. Nineteen of these 23 students are African nationals.

The project is funded through the VolkswagenFoundation's 'Africa-Initiative' (Knowledge for Tomorrow). Co-Funding of the project is available through CODESRIA (Council for the Development of Social Science Research in Africa), CEW (Cameroon Environmental Watch), CIRAD/CIFOR: Economic analyses of conservation strategies (CORUS project), and GIZ/KfW: Wildlife Monitoring.

Keywords: Africa initiative, cooperative research, livelihoods, Volkswagen Foundation

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Food Self-sufficiency or Foreign Currency Earnings? A Multimarket Modelling Assessment for Sudan

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The Gezira Scheme is Sudan's largest irrigation project. It lies on land between the Blue and White Nile, with a command area of 504,000 hectares. It was originated in 1911, when a private British enterprise found cotton suited to the area and embarked on what in the 1920s became the Gezira Scheme. Until recently, the scheme is specialised in the production of cotton for exports and for furnishing cotton to the local textile industry. In addition, the scheme produces sorghum and wheat as basic staple foods to maintain food security.

The Sudan's government started adopting food self-sufficiency policy during the 1940s by establishing the mechanised rainfed schemes. However, it further focused on it during the 1990s due to economic sanctions. Accordingly, the area cultivated by wheat and sorghum was enormously increased particularly, in the irrigated schemes. A peak of the subsidised wheat area was reached in 1991 when over 600,000 feddans were planted in Gezira Scheme.

However, by 1998, a removal of wheat subsidy and allowance of flours imports lowered prices, production, and led to continuous deterioration in area and output. In 2003, the food Self-sufficiency phenomenon was once again stressed due to the high annual import bill of wheat of over US$ 250 million. Hence, Gezira scheme was anticipated to cultivate more of wheat to secure the strategic goal.

Based on this background, this paper simulates the situation in a multimarket model, which is built and calibrated for Sudan's irrigated agriculture. The simulation considers switching portions of cultivated land between cash and food crops in order to reach a suitable mix where both self-sufficiency in food and foreign currency earnings are considered.

Results of a food self-sufficiency scenario indicates that it lead to a net loss in foreign earnings of $41.65 million and deterioration in producer surplus and welfare, besides falls in the government revenue from four crops that are considered in the study due to falls in tariff revenue. On the other hand, results of a cash crop cultivation scenario would increase net foreign exchange earnings, producers' surplus, government budget, and the overall welfare of the people.

Keywords: Agriculture, exports, food security, multimarket model, Sudan

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Chinese Coffee Farming in Transition

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Over 120 years coffee history in the Chinese province Yunnan is a struggle story between coffee leaf rust and plantation. To fight new emerged rust races, new coffee varieties are constantly introduced. For long-term success local coffee institutes established a unique germplasm collection with over four hundred varieties worldwide available for breeding purposes against coffee leaf rust. It provides new opportunities for coffee production, while industrial farming on large plantation imposes new challenges. Nowadays however, the whole coffee plantation is threatened, because the dominant coffee variety (Cartimor 7963) in both industrial and smallholder farms is no more coffee rust resistant. Small farmers are more and more under pressure due to shrinking margins and missing scientific information and financial support. Collective farmer cooperatives seem to be an effective solution to face the crashes caused by industrialisation and increasing technologic demand. Coordination of the different requirements from science, technology and economic development among the various actors, such as farmers, researchers, businessmen and local NGOs is required. Collective farmer cooperatives have the potential to become an efficient platform.

The paper examines different farmer cooperative models which exist and are promoted by the Chinese government. The industrialisation in coffee plantation, processing and marketing in Yunnan, China will be studied. A community-based system is investigated which includes stakeholder ownership of the development process and community engagement in project consultation. Ideally, local knowledge is combined with scientific research. At the end, the possibility of a connection between sustainable farming and fair-trade market will be critically discussed.

Keywords: Coffee rust disease, cooperative model, farmers, industrialisation, scientific demand, sustainable development, China, Yunnan

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Changing Face of Homegardens: A Case Study of Phong My Commune, Vietnam

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Homegardens have a long tradition in Vietnam. They contribute to the livelihood of a significant part of the rural population. The traditional homegardens stand out by the virtue of the nutrition benefit they have for a family. Nutrition and food supply are still the important aspects of homegardens in the community Phong My. Tree and particularly fruit trees are grown frequently (citrus species, star fruit, litchi, jackfruit, sugar apple, mango) but not more only for the own consumption. Nowadays up to 70 % of the total homegardens production is intended for sale. All families buy a significant amount of food at market which considerably turns farmer's production orientation. The majority of them displayed their intention to focus on cultivation of several cash crops (*Acacia*, betel nut palm, black pepper, cassava, jackfruit, pummelo, sugar cane, peanut). The particular example is one of the most frequently grown fruit tree pummelo (*Citrus grandis*) that is solely a matter of market production. These plans significantly alter income diversity, homegardens appearance and importance of their special functions and biodiversity which have also a severe environmental impact. Other contributing factors are soil erosion and natural disasters. The aim to change a number of grown species demonstrates that the production shift is an ongoing process. Farmers relay on lower amount of products than ever before and become more vulnerable due to the fluctuated market price. Income generated from homegarden has been ranked among the main income sources which shares total farm income by up to 76 %. The local agriculture practices obviously call for the intervention of the agriculture extensions that would propose the sustainable solution contributing to the environmental and economical improvements by using of local resources.

Keywords: Home garden, key crop, market, production orientation, tree, Vietnam

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Are Risk Preferences Consistent Across Assessment Methods? A Comparison of Hypothetical and non-Hypothetical Measures

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Although risk preferences have been examined in numerous studies, there still exists a knowledge gap on the accuracy of different methods to empirically assess risk preferences as well as the validity and consistency across methods. We analyze the validity and consistency of risk preferences assessed from hypothetical and non-hypothetical methods for people engaged in agricultural activities in a marginal upland area of northwestern Vietnam. The non-hypothetical method utilizes Holt and Laury lottery-choice task decisions with actual payouts ranging from €0.07 to €2.64, equivalent to approximately 11 % and 432 % of the average per capita daily expenditure, respectively. The hypothetical methods include lotteries of yield and price risk for maize and rice, the U.S. Federal Reserve Board's Survey of Consumer Finances risk-tolerance question, self-assessment questions eliciting the level of risk aversion, as well as scenarios about changing the household's sole income earning activity and selling an inheritance. In addition, respondents were asked what they considered to be risky non-agricultural investment and agricultural investment decisions. The consistency of risk preferences across methods is analysed with cross-tabulation and correlation analysis. Using principle component analysis, an index based on the different methods to assess risk preferences is created, offering researchers an alternative to assessing risk preferences by means of one method only. Data were collected in a random sample of 300 households in April and May of 2011 which is representative for the mountainous Yen Chau District, Son La Province. Nearly all households in this marginal environment are engaged in agricultural activities. Data on risk preferences were collected for the household head and spouse separately, allowing for a comparison of risk preferences within households as well as by gender. Moreover, differences in risk preferences between poor and non-poor households (based both on an absolute poverty line and a continuous relative poverty index) and ethnic groups living in areas of varying agro-ecological and infrastructural conditions are examined.

Keywords: Consistency, lottery choice task decisions, principle component analysis, risk preferences, Vietnam

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Beyond Resistance: The Current and Potential Livelihood Strategies of Kampung Kujang Sain, Sarawak Malaysia

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In the State of Sarawak on Malaysian-Borneo small rural communities rely on agriculture as a main source of food and income. While shifting cultivation of uphill rice forms the main source of subsistence farming, other activities, such as pepper and rubber cultivation, generate the necessary cash income. The strong modernisation ideology behind the Malaysian national Vision 2020 has put rural indigenous farmers under increasing pressure from the government and private companies to convert their land to large-scale commercial plantations. The village of Kujang Sain, Sarawak, has so far resisted such schemes; however, the reasons for and the dynamics behind the villages' resistance are deeply rooted and complex in nature. In order to investigate current and potential livelihood strategies in Kujang Sain, as well as the resistance to large-scale plantation schemes both social and natural science methods, such as Participatory Rural Appraisal and soil sampling techniques, were used. As the present livelihood strategies in Kujang Sain are based on natural resources, the research concluded that livelihood diversification is important if the villagers aspire to minimise the vulnerabilities associated with their current livelihood strategies. In addition, the findings reveal that the resistance to large-scale plantation schemes was linked to the villagers' negative perception of these schemes in combination with an ongoing internal social conflict. Thus, households in Kujang Sain have the potential to diversify and develop. However, this may only be plausible if the community addresses its most significant vulnerability, which is the absence of social cohesion.

Keywords: Borneo, livelihood diversification, livelihood strategies, livelihoods, Malaysia, palm oil plantations, plantation schemes, Sarawak, shifting cultivation, social conflict, subsistence agriculture

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Drought Vulnerability in Resource-based Livelihoods in the Lake Naivasha Catchment

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Kenya is a drought-prone country that suffers regularly from drought-related food shortages. The situation in the lower Lake Naivasha Catchment is of special interest in this context, as not only small-scale farmers, but also a huge number of commercial farms, employing roughly 25,000 people, are resource-dependent, especially on water for irrigation. Finally, the regional tourism business depends on regular rainfall and sufficient inflows into Lake Naivasha, as otherwise the area's attractiveness as a travel destination would suffer. The question arises how households engaged in resource-dependent activities are affected when rains fail, and how they cope with this to secure their livelihoods. The aim of this study is to investigate the drought of 2009 with respect to impact, coping and vulnerability, and to identify differences between the different main income-generating activities (IGA). For that purpose, a survey of 220 interviews among households, classified into four groups of IGAs, was carried out. Based on the responses, typical livelihoods were defined and their vulnerability to drought (as the outcome of impact and coping) was assessed.
Concerning drought impact, yield decrease, livestock mortality, real income decrease, price change and health problems were assessed. To cope with the drought, changes in household expenditure patterns as well as engagement in alternative sources of income and food were analysed, *e.g.* reliance on social networks, change of food consumption patterns, sale of assets, or intensification of agriculture. Vulnerability was measured by two different outcomes, real income decrease and change in food consumption patterns. The results of correlation analyses show that the vulnerability assessment heavily depends on how vulnerability is defined.

Keywords: Drought, Lake Naivasha, livelihood, vulnerability

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Application of Risk-rated Profit Model Function in Estimation of Economic Values for Indigenous Chicken Breeding

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The economic values for productive (egg yield, EY, average daily gain, ADG, live weight at 21 weeks, LW and mature weight, MW), reproductive (fertility, FER, hatchability, HA and broodiness, BROD), adaptability (survival rate, SR), efficiency (feed intake, FI) and aesthetic (egg weight, EW) traits were derived for three production systems utilising indigenous chicken (IC) in Kenya. The production systems considered were free range system (FRS), semi-intensive system (SIS) and intensive system (IS) and were evaluated based on fixed flock size and fixed feed resource production circumstances. A bio-economic model that combined potential performances, feeding strategies, optimum culling strategies, farmer's preferences and accounted for imperfect knowledge concerning risk attitude of farmers and economic dynamics was employed to derive risk-rated economic values. The economic values for all the traits were highest in FRS under the two production circumstances and decreased with level of intensification. The economic values for EY, ADG, LW, FER, HA and SR were positive while those for MW, BROD, EW and FI were negative. Generally the economic values estimated under fixed feed resource production circumstances were higher than those derived under fixed flock size. The difference between traditional and risk-rated economic values ranged from -47.26 to +67.11 % indicating that inclusion of risks in estimation of economic values is important. Traditional economic values were sensitive to changes in prices of eggs, live chicken and feeds. The results of this study suggest that improvement targeting EY, ADG, LW, FER, HA and SR would have a positive impact on profitability of IC production in Kenya.

Keywords: Economic value, indigenous chicken, production system

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Socio-economic Factors Affecting Farm Cash Income in Urban Agriculture in Khartoum, Sudan

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The expansion of the built-up areas over the last 50 years in Khartoum puts high pressure on arable land for food and feed production in and around the city. In 1993 11 % of Khartoum's population owned agricultural plots planted to crops used for self-sufficiency or sale. Since then a substantial increase in land use competition has occurred which has affected both, the urban crop production and the livestock sector. The objectives of this study were to investigate the changes in farm resource use, and cropping patterns, and to model socio-economic factors affecting the cash income of farmers involved. Therefore 45 crop and 30 dairy producers were randomly selected and interviewed first in 2007 and a second time in 2009 using a semi-structured questionnaire. The information collected included age and education of the farmers, their farm location and size, cropping patterns as well as fertilisers prices and quantities, number of livestock kept, and their sources of income.

Descriptive and non-parametric statistics (Mann-Whitney U test) were performed to test the differences between 2007 and 2009 for the observed parameters. Generalized Estimating Equations (GEE) was used to analyse the effects of a set of socio-economic factors on farm cash income.

Within the two-year period, only a slight change in farm size (+4 %) and in total livestock units (TLU) (-6 %) was observed while crop intensity decreased by 25 %. While urea prices varied significantly over time (z= -8.866***), the use and price of chicken manure and liquid foliar fertiliser remained rather constant. The farm location (urban versus peri-urban) did not significantly affect farm cash income. Education, farm size, and milk productivity significantly enhanced farm cash income while chicken manure and the area of fodder decreased it. This raises questions about the use efficiency of chicken manure and of fodder cultivation in the study area.

Keywords: Cash income, socio-economic factors, urban farms

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A Strategy for Rural Development: Promoting Entrepreneurial Behaviour among the Youth of Mozambique

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Empirical evidence has repeatedly highlighted that business ventures are mainly initiated within the community by its original members. Entrepreneurs tend to set up their businesses in close proximity to where they live or to the organisations where they have acquired their skills and knowledge. They tend to maintain linkages with their original communities even in case of relocation/expansion of their business to other sites, at a later stage. Why are some communities more entrepreneurial than others? Besides institutional factors, empirical studies have shown that the community members' attitude towards business activities plays a significant role in promoting venture creation locally. Can this attitude be fostered?

Entrepreneurship education in schools is a strategy in this direction. All over the world, governments are increasingly mainstreaming entrepreneurship education in their education systems to foster an entrepreneurial mindset in their population at an early stage. By stimulating enterprising attitudes in students and equipping them with basic business knowledge, governments in developing countries attempt to provide their youth with a forward outlook on life, which will, in turn, inject dynamism in their communities.

What evidence exists about the effectiveness of entrepreneurship curricula to stimulate enterprising attitudes and entrepreneurial behaviour among the youth? The present study is the first one of a larger plan to investigate the effectiveness of a number of entrepreneurship education programmes in Southern Africa. Using a sample of some 600 secondary school students that have been undertaking an entrepreneurship education course in Mozambique, the study explores the role that a range of socio-demographic parameters (age, gender, social background, etc.) play in determining students' actual engagement in business activities. The study reveals that students, irrespective of gender and social background, exhibit a remarkable entrepreneurial behaviour, and that school context can constrain such behaviour. Furthermore, it is observed that these students tend to transfer their entrepreneurial knowledge and skills to members of their community. Finally, the results suggest that entrepreneurship development reinforces students' interest in further education unlocking the potential of engaging in a wide range of career initiatives.

Keywords: Entrepreneurship, rural development, Mozambique

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Communication and adoption

Participation Is Not for Free: A Cost Study on the Application of Participatory Variety Selection by Mother-and-Baby-trials for Potato Breeding in Peru

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The problem of slow and low adoption of improved seeds and other new technologies by smallholder farmers gives foundation to a large body of participatory research literature. The necessity to overcome a knowledge and communication problem between researchers and farmers calls for an improved integration of the farmer's perceptions, preferences and attitudes in research design, testing and diffusion. This especially applies for marginalised target groups like income and endowment poor farmers with difficult input and output market access and/or difficult agro-ecological conditions.
Participatory Plant Breeding (PPB) refers to a spectrum of activities which can have different modes of how farmers' participation is organised, at which stage of the research and innovation process it is taking part and to which degree the farmer participates. Participatory Variety Selection (PVS) implies a participation of the farmer and other agents of the value chain at an intermediate to final stage of the breeding process. Mother-and-Baby-Trials (M&B) is a rather novel design further developed by the International Potato Center (CIP) which addresses the need for a quantitative methodology and statistical procedures to learn about farmers' criteria for potato variety selection.
Favourable outcome effects and impacts of PPB in comparison to conventional breeding have been documented and discussed in the literature, pointing out the complexity of the analysis in terms of benefit quantification, time horizon and counterfactual scenarios. Published literature thereby reveals that the issue of the necessary costs to be invested for implementation of specific participatory methods is under-researched. If applied international agricultural research (*e.g.* done by the CGIAR system) strives for policy incidence in the sense of recommendations finding their way into national polities and development policies (*i.e.* institutionalisation) decision makers have to be informed about those costs.
This empirical study analyses the implementation of the M&B method in all its phases in 17 communities within the Cambio Andino/ RED LATINPAPA partnership programme where CIP is testing various participatory methods in cooperation with diverse organisations (governmental and NGOs). Based on the case-wise application of the method's protocol in field the direct and indirect expenses as well as opportunity costs of participation are analysed.

Keywords: Costs, participatory variety selection, Peru

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Innovation Behaviour among Smallholders: Evidence from the Peach Value Chain in Cochabamba, Bolivia

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There is increasing empirical evidence that farmers not only decide to innovate on the basis of economic and personal considerations, but also on the context of the social interactions they maintain among themselves and with agents who promote change. The focus of this study was on how communication within the social networks of farmers influences their decision to innovate.

Three communities in the Valle Alto of Cochabamba, Bolivia, were studied with regard to their social interactions and the degree to which innovations in peach production and marketing were applied. All peach producers in the communities were interviewed. Variables denoting the embeddedness of farmers in the network were derived using social network analysis. Those variables together with variables on demographics and resource endowment were used in a multivariate regression analysis to determine if "embeddedness in social networks" significantly contributes to the innovativeness of farmers. The information exchange networks were also visualised using NetDraw software.

The results show that the connectivity of farmers in social networks allows for the exchange of information on improved practices and innovations in peach production and marketing. Though the effect on innovativeness is significant, its effect is marginal. Results also show that farmers do not communicate actively on such issues. A further analysis of the type of innovations available to the farmers reveals that many of them did not yet contribute to substantial increases in production and income. One may argue that the available innovations were simply not substantial enough to make diffusion through the network and application on farmers' fields worthwhile.

The Program of Continuous Innovation (PIC) of the Swiss Agency for Development and Cooperation and similar programs may note that it is important to consider and improve social interactions when fostering innovation. PIC may be advised, for example, to strengthen producers associations in a way that they promote communication about innovation and marketing opportunities. This, however, may only be effective if ideas and solutions are present inside the farming community and among development agents in order to bring considerable benefits to the potential innovators. Assuming that farmers would develop their own solutions is not realistic.

Keywords: Change agents, diffusion of innovations, peach value chain

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Increasing Farmer Participation in Institutional Innovative System: The Case of Dairy Hub Marketing in Kenya:

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The total available area for sustainable agriculture in Kenya is about 17 % of the country's land area. As the country's population pressure on land increases, growth in agricultural production must substantially come from enhanced productivity of land already under cultivation, and from capital investments in transforming marginal lands to zones of high-value agricultural production. While this would increase pressure on marginal lands, increasing productivity will reduce pressure on these (marginal) lands. This is because intensification will reduce the need to expand production into marginal fragile lands. Improved smallholder dairying has long been identified as a route towards enhancement of the country's agricultural production. Eastern Africa is Africa's most promising region for dairy production with Kenya having one of the largest dairy industries in the region. History shows that Kenya's dairy industry has evolved through a sequence of distinct phases that saw the collapse or reorganisation of the industry: from establishment of organised milk marketing through a state-controlled system of cooperatives, to the collapse of the system, that left the producers with the duty of coordinating both production and marketing themselves. Collective milk marketing, through cooperatives and farmer groups, still appeals to farmers owing to economies of scale, convenient payment arrangements and, access to input credit as well as other dairy related services. However, cooperative development efforts have for the past years, not yielded the desired impacts. For efforts to improve and encourage sustainable intensification in smallholder dairy business though institutional innovative system (in this case, the "dairy hub marketing") to yield fruits, clear understanding of barriers and opportunities is pertinent for targeting in order to increase intensification. This study uses a tobit model to analyse factors that affect the intensity of use of dairy marketing Hubs in the East African Dairy development project. Primary data was collected from 300 dairy farmers in Western Kenya milk shed. While farmers using the hub were found to have a comparatively high economic endowment, indicating the merits of hub participation, the analysis reveals the need to prioritise the focus on increasing dairy intensification and consequently milk production through breed improvement and other production-relevant strategies while investing in elaborate market access system.

Keywords: Dairy, Hub marketing model, intensification, market access

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Adoption of Resource Management Technologies in Small-Scale Farming Systems: A Matter of Resource Poverty or Knowledge Compatibility? Experiences with Legume-based Technologies in Southern Benin and Northern Nigeria

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Resource management technologies (RMT) are to fulfil long-term objectives rather than subsistence-securing goals. Furthermore, RMT are reputed to be knowledge-intensive, transformational of whole farming systems, and therefore not acceptable for smallholders. To circumvent these adoption inhibitors, there is a consensus in the legume research literature that legume-based technologies (LBT) should be targeted without emphasis on their resource management attributes. As in the present study, which was conducted in southern Benin and northern Nigeria, multi-purpose grain-legumes should be promoted for their multi-functionality in delivering grain for food and biomass for soil fertilisation or livestock feeding. Green manure legumes should be targeted primarily to serve concrete needs such as combating *Imperata* or *Striga* and not per se for soil improvement. By using legumes in these or similar utilitarian senses, farmers would unintentionally strive for resource management as collateral effect.

In order to detect the particular circumstances that favour farmers' utilisation of LBT in the humid and dry savannahs of West Africa, two baskets of herbaceous legume options consisting of green manure, forage, and grain-legumes were introduced along the resource-use gradients in southern Benin and northern Nigeria.

The improved varieties of grain-legumes were accepted independently of any further special circumstances but depending upon their relative advantages over local varieties. Surprisingly, the acceptance of the non-grain legumes did not depend on any special biophysical or socio-economic context. Local knowledge on soils and fertilisers was the main driver for the acceptance of these legume options. In southern Benin farmers chose both grain and green manure legumes that they used on differentiated fields according to local field and fertiliser taxonomy. In northern Nigeria, however, the local taxonomy of soil fertilisers and feedstuffs attributed to the offered green manure or forage legumes the same value as that of native grasses, which were not considered worth of adoption. In the latter case, the explanatory power of resource poverty as determinant of the uptake of LBT by smallholders was biased by farmers' knowledge.

In conclusion, both local knowledge and farmers' circumstances need to be addressed for promoting LBT more successfully.

Keywords: Benin, knowledge compatibility vs. resource poverty, legume adoption, Nigeria, resource management technologies

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Variety Adoption of Orphan Crops by Smallholder Farmers in Tanzania – A Survey Based Choice Experiment

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In Sub-Saharan Africa, 75 % of the extreme poor are living in rural areas and agriculture is one of the principle ways out of poverty for them. As possibilities to extend the cultivated area are limited, productivity gains will be needed to increase future agricultural production. The improvement of seed technologies is expected to play a crucial role in this context. In the last decades, research was mostly undertaken in regard to crops for high potential areas and so called orphan crops that are especially suitable for semi-arid areas have been overlooked.

Sorghum and finger millet are two orphan crops that are widely grown in the semi-arid regions of Tanzania. For sorghum, a number of improved varieties has already been released, but adoption rates have generally been very low. Previous studies point out several reasons for low adoption rates, but they also have some shortcomings. One of them is that farmers' stated preferences for variety traits are not considered. Thus an important factor for explaining adoption behaviour and proposing seed technology improvements is missing.

The objective of our paper is to provide recommendation for the promotion of improved varieties of orphan crops. We use a unique data set from a household survey that was conducted with 360 households in two major finger millet and sorghum growing regions in Central Tanzania in September 2010. A choice experiment for finger millet was embedded in the survey. The collection of revealed and stated data allows us to assess the adoption behaviour of smallholder farmers from two different angles. First, we estimate a binominal probit model to identify general adoption constraints, and second we assess farmer's trait preferences by estimating a conditional logit model that is based on the data from the choice experiment. This analysis gives us insights about the major constraints that farmers face in the adoption of improved sorghum and finger millet varieties and at the same time identifies farmers' trait preferences. Hence, this study will provide policy recommendations as well as priorities for future research on seed technology improvements.

Keywords: Adoption, choice experiment, improved varieties, orphan crops, Tanzania

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Understanding Adoption of System Technologies in Smallholder Agriculture: The System of Rice Intensification (SRI) in Timor-Leste

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Against the background of rising food demand, decreasing productivity growth, and environmental degradation, natural resource management technologies, such as the system of rice intensification (SRI), have been propagated, especially in a smallholder farm context. However, system technologies are often location specific and characterised by partial adoption and disadoption. Previous studies were often not able to fully explain this, because they mostly relied on farm and household level data, neglecting plot level differences that may be important. We address this limitation, using SRI adoption in Timor Leste as an example. Regression models are specified and estimated to explain farmers' decision-making processes. Participation in training programs and household labour availability increase the probability and intensity of adoption, as SRI is knowledge and labour intensive. However, many other household variables are not significant, while detailed plot level characteristics have more explanatory power. Our findings reveal that the availability of a technical irrigation system, which can be controlled individually by the farmer, is an important determinant of SRI adoption on a particular plot. Hence, the establishment of improved irrigation systems would be conducive for more widespread SRI adoption. Close proximity of a plot to the homestead, also has a positive effect on adoption, as this facilitates experimentation and monitoring. Improved rural infrastructure would help facilitate plot access and thus SRI adoption. Other plot characteristics that influence adoption include soil conductivity, loam content, and slope. The results suggest that plot level data are important to understand the adoption of system technologies. Moreover, technology adaptation to different plot conditions seems to be a precondition for widespread diffusion. For this, training programs have to be sufficiently flexible and location specific, presupposing new skills set among training and extension agents, including experience with participatory learning.

Keywords: Double-hurdle models, cooperative research, funding, livelihoods, system of rice intensification, SRI, technology adoption, Timor Leste

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Mobile Phones are Just More than Phones in the Hands of Farmers

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One of the major constraints for improved commercialisation is the existence of an efficient marketing system. Small-scale farmers access to market information and overall to better markets remain still very low. In this regard, a pilot project in improving access to market information through mobile phones was implemented in the central rift valley area, which is one of the areas with better infrastructure in terms of roads and telecommunication. This paper documents the experience gained and assesses the impact of access to mobile telephone on access to markets thereby farmers' income.

The study was conducted in the central rift valley areas namely in Adama, Dugda, and Adami Tulu woredas (districts), which are known for the production of diversified crops including cereals, pulses, vegetables and fruits. Farmers that were organised into FRG (farmer research group) were provided with a mobile phone one for each FRG to improve their access to market information thereby markets not only in the nearby town but also in distant markets .

Farmers access to online market information: new channels for marketing such as direct negotiation with traders avoiding brokers, access to further market places, exchange of information between farmer groups and the impact brought have been analysed. The following encouraging results have been observed: reduced costs of marketing by avoiding guess work, farmers were able to fetch better market opportunities, bargaining power has been improved, farmers started group marketing, and changes on decision pattern and marketing have been observed. Furthermore, the majority of farmers' production pattern has changed. They started to produce which they learnt have steady and high market demand which is an indication that farmers have started to follow market oriented agricultural production. Mobile phones can be an important low cost intervention in areas with limited infrastructure in terms of communication.

Keywords: Commercialisation, farmers, market information, mobile phones

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The Role of Extraneous Incentives and Drivers in Farm Enterprise Diversification: A Study of Passion-fruit (*Passiflora edulis*) Uptake in Uasin-Gishu County, Kenya

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Despite the continued production and overdependence of traditional crops (mainly maize and wheat) as main source of income in Uasin-Gishu County, poverty among farmers has been increasing. To mitigate the poverty effects, farmers have tended to substitute land under the traditional crops for high yielding and high value crops, passion fruit inclusive. However, the adoption of passion fruit has been achieved with partial success. Previous studies indicate that approximately 1500 out of 166,635 farmers in the County have adopted passion fruit since its introduction in Kenya in 1933. This study determined the extent of passion fruit adoption, factors affecting the adoption and its extent. Cross-sectional data from 100 randomly selected farmers were collected and subjected to Heckman two-step regression analysis to determine factors affecting passion fruit adoption as well as the extent of adoption. The results show that availability of water for irrigation (marginal effect=0.481), title deeds (marginal effect=0.316) and farming as main occupation (marginal effect=0.486) significantly and positively affected the adoption of passion fruit while age (marginal effect=0.009) was significant with negative effect. Private land ownership and access to extension services significantly and positively influenced the extent of adoption while age had significant negative effect. The results mean more incentives and innovative drivers are necessary for crop diversification and substitution in Kenya and not sufficient for adoption of the new crops. Government and other stakeholders should therefore formulate and implement effective policies related to promotion of adoption, production and marketing of new agricultural technologies especially among rural small-holder farmers.

Keywords: Adoption, high value, high yielding, passion fruit, traditional crops

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ICT-based Market Information Services Show Modest Gains in Ghana's Food Commodity Markets

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The role that information and communication technology (ICT) based market information services can play in linking small scale operators to markets have not been overlooked in existing policies on agriculture and information communication technologies in Ghana. The ICT4AD (ICT for accelerated development) policy and the Food and Agricultural Sector Development Policy documents attest to this fact. Government as well as private sector agencies have made modest investments in the provision of such services in the last decade. The Esoko/Tradenet platform which makes price information available through mobile sms, the Community Information centres and the Agricultiral Informations centres in selected markets are projects implemented after 2006 to boost market information flow. How small scale marketers and producers of agricultural commodities have responded and whether there has been an impact on price integration between source and destination markets for staple food commodities is the concern of this paper. Primary data from 11 markets and 486 marketers was used to describe the current practices and firm level performance. Monthly price data from 2004–2009 was used to fit the Ravilion-Timmer model to show the extent of market integration between rural and urban markets. The results of the study showed that the mobile phone is the single most important ICT tool that is facilitating the speedy dissemination of market information on prices, volumes, road condition, among others. Complementary services such as good road surfaces and networks, good condition cargo vehicles, adequate urban market spaces and facilities and low-cost packaging and handling services are lacking. As a result there is limited market integration; the market connectedness values showed that there is short run integration for groundnut but not for maize and yam. The conclusion is that ICT-based market information services should continue but more should be done to improve the broader market infrastructure base in the country.

Keywords: Food staples, Ghana, ICT, market information

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Communication Content and its Implications on Local Responses to Conservation Initiatives

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Appropriate communication content that touches on the reality and experience of local people is an important tool in engendering understanding and support for conservation initiatives. This paper examines the communication content of Nigeria National Parks and its implications on local responses to conservation initiatives. It is based on the study conducted in the seven national parks in Nigeria. The parks include Chad Basin National Park (CBNP), Cross River National Park (CRNP), Gashaka Gumti National Park (GGNP), Kainji Lake National Park (KLNP), Kamuku National Park (KNP), Okomu National Park (OKNP) and Old Oyo National Park (OONP). These parks are located in various ecological zones of Nigeria. A total of 1170 inhabitants of support zone communities of the parks were sampled. The methods of data collection were focus group discussion and individual interview through questionnaire administration. It was revealed that the contents of the parks' communication with the communities were illegal activities, protection of park resources, prohibition of resource use, cooperation with park management, park laws, and conflict resolution. However, less emphasis was on alternative resource use and sustainable livelihood, strategies through which they could benefit from ecotourism, damage to crops by wildlife, wildlife attack on humans, provision of infrastructure and amenities, employment, and how they can be involved in park management. The implications of parks' communication content on local communities' support for park policies and activities were highlighted. The paper concluded that conservation agencies in developing countries require a systematic and holistic communication strategy that takes into account people's needs, concerns, and a sense of integration in protected areas management for any meaningful success in conservation activities.

Keywords: Communication content, conservation initiatives, implications, local responses

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Extension Services and Research Demands – A NGO Perspective from four African Countries

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Sasakawa Africa Association (SAA) is an international NGO, working in agricultural extension and advisory services in more than 15 African countries for the last 25 years. Presently, SAA operates in Ethiopia, Mali, Nigeria and Uganda through the respective national agricultural extension services (NAES) providing training to extension agents and operational funds for the implementation of Farmer Learning Platforms, demonstrations of agro-processing equipment, and supporting value-chain development by linking farmers to markets. Hence SAA aims at developing farming communities with a holistic approach by using scalable and cost-effective approaches. Nevertheless, agricultural productivity remains low, for example, cereal crops still yield only 1 to 2 $t\,ha^{-1}$ on average with top yields of 3 to 4 $t\,ha^{-1}$ in high potential, mainly highland production zones. SAA has shown in field demonstrations that these yields can be improved considerably with simple agronomic technologies.

Despite these potential increments in productivity there are still research questions regarding the efficiency and sustainability of input use, the interactions of the different components of technology packages, which are often considered too basic by international and/or advanced research institutions but which cannot be tackled by the national research systems because of lack of funds or capacities. For example, there are mainly blanket recommendation rates for fertilisers for most crops, while there is little information on fertiliser placement, on timing, splitting or mode of fertiliser applications, possible interactions with plant population density, row planting or organic fertilisers. More precise information could increase input use efficiency, reduce costs and improve profitability, which in turn would result in greater adoption rates by farmers and a more sustainable agricultural production system.

SAA has therefore increased its training efforts with extension agents and farmers, emphasising agronomic concepts instead of specific crop agronomy and is seeking actively support from research either for new adaptable technologies or to respond to farmers' needs. This partnership could be mutually beneficial as SAA has the capacity and the direct connection to farmers and NAES to test and verify research results while research institutions could demonstrate impact of their technologies and guide their resource allocation according to farmers' needs and priorities.

Keywords: Input use efficiency, research institutions, Saskawa Africa Association

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Participatory Rural Video Centre: An Approach to Support Learning and Farmers' Innovation in Bangladesh

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Extension services often miss the opportunity to support farmers' innovation in Bangladesh. This is partly due to lack of creative and innovative ways to support farmer-to-farmer learning. Over the years potential use of video to support farmer-to-farmer learning raises interests on how best to use the media. A new debate raises the issue whether farmers should have complete freedom to shape the video-based learning material or they should collaborate with the development professionals to develop effective learning materials. In this paper, following a normative review of concepts and empirical evidences we present an approach to develop local video capacity through establishing a video centre in a north-west village of Bangladesh. The approach recognises the complementary advantages of two styles of participatory video (PV) to trickle down the benefit of the capacity of filming to the rural community. We argue that introducing video to a team of rural men and women inspires their experimentation capacity. The centre is a social space where local innovation actors can be engaged to enhance learning within and beyond the community. The sustainability of the centre depends on the networking with the rural video professionals and how the rural video team engages them in the landscape of local innovation actors in rural Bangladesh. The objective is to develop the centre as a farmer organisation, which will support video-mediated innovation and learning process in the community. The participatory rural video centre is established to have a long-term exit for the video-mediated women farmers' empowerment process in the community.

Keywords: Bangladesh, innovation, learning, rural, video

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Interdisciplinary Analysis and Assessment of Innovation Transfer to Farmers in the Red River Delta, Vietnam

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The Red River Delta (RRD) is one of two biggest deltas in Vietnam. The region is the origin of paddy rice in the country. Agriculture plays an important role for Vietnam's economy, especially in the RRD. Recently, adoption of innovations in agriculture has enhanced the quality and quantity of production. Old varieties of crops have been replaced and improved management practices as well as production methods such as Integrated Planning Model (IPM) have been implemented.
This research project focuses on the question, whether there is a necessity to enhance the process of innovation transfer to farmers. Social-economic conditions of the region have to be taken into account. The project will evaluate the existing transfer system and tries to find out if it is possible to improve the innovation transfer by interfering into the process.
The interdisciplinary research project uses the theory of diffusion of innovation, the theory of collective action, and other explanations such as the cultural effect and individual behaviour. The results of this paper are based on 15 expert interviews and 85 detailed questionnaires of smallholder farmers.
The cooperation between farmers and agents of extension services, S&T organisations, agricultural enterprises, NGOs will be described. In some cases, the process of innovation transfer to farmers happens directly because of agreements in a contract between partners, or motivated by incentives, or simply pursuant to a learning process following diffusion of information through networks. The role of farmers in these processes is also directly observed as an active or passive participation. Farmers are classified in groups of adopters (potential adopters, early adopters), imitators (later adopters) and non-adopters and factors to explain the adoption behaviour are discussed.

Keywords: Adoption of innovations, agricultural economics, diffusion of innovations, innovations transfer, planned behaviour

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Role of Institutional and Farm Specific Factors in Influencing Participation and Extent in Tree Planting

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The study evaluated factors influencing participation in tree planting programme and the extent of participation in Nyeri district, Kenya. With many studies focusing only on the factors influencing participation, drawback often arises from self selection but the study employed Heckman two stage sample selection model in analysis to deal with this. The International Smallgroup and Tree Planting Program (TIST) has targeted Nyeri district to engage farmers in environmental conservation by planting trees while at the same time increasing their incomes. The program's approach is to use a variety of institutional innovations to attract farmers and these include payments for raising trees and inclusion of a micro finance programme in their model. Farmers are increasingly joining the programme substituting land previously allocated for food crops with tree planting enterprise. Given that poverty is high, food insecurity is looming in the country and that the existing factors of production face further pressure, the study focused on analysing the factors that drive farmers towards participation in the program. Various socioeconomic, farm specific and institutional factors that affect participation and the extent in tree planting programme were considered in the analysis. Multistage sampling was applied in selecting 120 farmers. The results showed that farm size, access to micro-finance and programme awareness positively influenced participation and extent and were significant at 5 % level of significance. This implies that increased participation can be enhanced through increased awareness of programme benefits and institutional innovations such as inclusion of microfinance in the programme model that will attract smallholders.

Keywords: Participation, tree planting

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Information and Communication Technologies Directed to the Local Development and Social Empowerment

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In recent years, we have observed a rapid evolution in the concept about Information and Comunication Tecnology (ICT) like a research about new mechanisms to promote a culture and social development. The ICT are understood as a group of audiovisual, computer and communication that allowed creating, store, recovering and transmitting a lot of information in high speed. This technologies, such as the internet, bring social, cultural and communicational changes. It allows the exchange of information, experience and skills in real time, the formation of interest groups, alliances and improve the network at local, regional, national and transnational. According to Standage (1988), a technological subculture with its own customs and vocabulary was establishing itself. In this way, we try to reflect the way ICTs can contribute to local development in Concordia/SC after the internet access became possible in a rural area due to a participative budget. Already the Internet is regarded as an invaluable source of information. A literature research with researchers who study about ICTs, rural communication, participatory democracy, empowerment, social capital and local development was carried out. Besides that, a documental analyses about the "Regimento Interno do Orçamento Participativo" (The bylaws of participatory budget) was done as well as participant observation and informal interviews with three farmers. In this context, the ICT represent a new alternative to the participation of citizens who find themselves out of the process of decision making in the public interest by assisting in overcoming the obstacles imposed on the development.

Keywords: Empowerment, information technology and communication, participatory democracy

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The Role of Agricultural Service Organisations in the Process of Agricultural Transformation in the Khorezm Province, Uzbekistan

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Uzbekistan has experienced a chain of agricultural reforms since 1991. The Uzbek government maintains strong control over its agricultural production to ensure food security and economic growth. The process of de-collectivising land crucially modified inter-human relationships within the agricultural production system, as well as between the now diverse groups of agricultural actors and the state.

Agricultural service organisations (AgSOs) play a crucial role in offering agricultural inputs, sales organisations, financial and insurance services to transform the agricultural economy of Uzbekistan. Originally, AgSOs were established to serve state collective farms during Soviet times, and were centrally managed. Yet, due to agricultural reforms, that led to the creation of individual-owned farms, AgSOs have moved from being centrally managed and providing services for a few state farms to providing services to a much larger contingent of individual farmers.

In this poster, I examine the role of agricultural service organisations, particularly the Machine-Tractor-Part (MTP), Fertiliser Company and Bio-labs in the agricultural transformation processes in Uzbekistan. The central research question is what happened to AgSOs in the Khorezm region of Uzbekistan during the ongoing processes of agrarian change? The data was collected through various qualitative methods between 2009 and 2010.

Initial results showed that these organisations apart from providing services (*i.e.* provision of fertilisers, seeds, machinery, consultations, etc.), fulfiled many other socio-political functions during the agrarian change process. These include various tasks requested by the state administration, such as providing machinery to state farmers, participating in numerous meetings arranged by the state administration with regard to organising cotton and wheat agricultural campaigns, fulfiling the private tasks of bureaucrats, as well as relicts from Soviet times such as acting as a social security net for its personnel. The analysis reveals that agrarian transformation has produced three types of service organisations, which differ in its relationship to the state, financial wellbeing and potential to develop into private sector, etc.

Keywords: Agricultural services, organisations, post-socialist transition, rural development, transformation, Uzbekistan

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Intensifying Fish Pond Business: An Interdisciplinary Innovation Study on Information Needs of Black Thai Farmers in Chieng Khoi Commune, Vietnam

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Small-scale pond aquaculture has been described as a valuable farming activity to solidly supply the rural poor of the Vietnamese Northwestern Mountainous Region with additional animal protein. With practically every household in the area having at least one fish pond, prevailing practices in the traditional pond aquaculture tend to be resource-driven and, moreover, highly affected by the surrounding land uses, therefore bringing out fluctuating yields far below its potentials. Consequently, the urge to sector innovation is increasing, notably due to the infestation of the grass carp as the main species by an unknown species-specific disease that was cyclically emerging over recent years.

This interdisciplinary study departs from preliminary findings of tested improvements in the local aquaculture. Applying qualitative research methods with an emphasis on group discussions and interview-techniques, farmers' perceptions were analysed of how to bridge the gap between the status-quo and the utilisation of the recommended practices as described by researchers, grounding our study in theories of innovation diffusion and behaviour modification. The analysis approaches the envisaged fish pond reform by tracing back the innovation history of roughly 30 years since aquaculture was largely introduced, and assesses the current local knowledge on aquaculture. In a second step, the study links historical driving and limiting forces to innovation with current constraints to fish pond reform from a farmers' point of view. The traditional system evolved as low input- and subsistence-oriented side activity to paddy rice farming. Turning it into a more valid business by adopting all proposed measures must be seen as a rather radical innovation that cannot build much on any existing experience and knowledge of farmers. The promising action-research experiments with pilot farmers are not yet sufficiently understood and adoptable by their peers. This indicates strong information and extension effort has to be made, once the new system is ready to be introduced. In conclusion, intensifying fish pond business will be an immediate option for few better-off farmers only. If poor farmers should also be able to profit from the innovation, new institutional arrangements like "share-cropping" or "producer-association" have to accompany the technical and economic innovations.

Keywords: Extension, innovation adoption, semi-intensive aquaculture

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The Immediate Social-economic Impacts of an Implemented Project in Northern Vietnam (Lang Son, Cao Bang)

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The survey is dealing with the immediate real impacts of already implemented project "Support of freshwater fish farming in the mountain areas (Vietnam)". The project was financed by the Czech Ministry of Agriculture under the heading of official development assistance and lasted for three years. The overall objective of survey was to find out the immediate real impact of above mentioned development project in social and economic sphere on involved people. The specific objectives were focused on the overall situation of mountainous regions and most pressing problems hindering the development and also on aid´s beneficiaries in terms of knowledge (technology) dissemination among other people living in regions and thus contribution to poverty reduction and development. The research consisted of primary data collection done in the last phase of the project realisation. Since the respondents and the area present a specific environment also the combination of used approaches was necessary to implement. Research thus stands in between the qualitative and quantitative approach with the sociological empirical research as the main used method. The final results show that even though the project just ended, it already had several impacts which are already visible. Among most important impacts which were already possible measure belongs the income improvement, wider structure of activities related to improvement of living standards etc. Also it was possible to observe that some of the involved people are no longer dependent on project´s support and they already preparing for next production period from their own assets. In the social sphere had the project many interrelated impacts. One of the most important things was the persistence of the good relations with families measured by the time spent together, good labour distribution among cooperative´s members who share new responsibilities equally, willingness to continue with aquaculture and improve the current standards and also to share the new knowledge to other people in regions. There were already measured several more impacts, these impacts will be however more remarkable after a longer period of time and they should be again surveyed. Then they can contribute to a better understanding of the Vietnamese society and contribute to future successful project realisations.

Keywords: Aquaculture, cage culture, cooperatives, culture based fishery, evaluation, Northern Vietnam, social capital, sociological empirical research

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Adoption and Productivity Impacts of Biotechnology for Orphan Crops: The Case of Tissue Culture Bananas in Kenya

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The benefits of relatively knowledge-intensive technologies that require supplemental inputs are not well known in literature. Moreover, there are no known studies investigating technology impacts on perennial crops. Using the case of tissue culture (TC) bananas in Kenya, we assess whether there are differences in banana production functions between TC adopters and non-adopters using a simultaneous equations model with endogenous switching. We account for heterogeneity in adoption decisions and for unobservable characteristics of farmer households and their farms and then compare the expected banana yield under the actual and counterfactual scenarios. Because of banana's perennial nature, we also assess technology impacts over time by considering plantation age characteristics, a method not used before. We find that adopters and non-adopters are systematically different with regard to personal and farming attributes. Agricultural information access matters for adoption but also for productivity benefits. TC banana yield effects are well achieved within supporting institutional frameworks and when supplemented substantially by irrigation water. We find that TC technology has only helped reclaim lost yields of smallholder farmers but there are no sufficient yield improvements above the expected average. TC productivity effects peak in middle-aged TC plantations but may remain relatively higher in later crop-cycles. This implies that traditional impact assessment methods, as would be appropriate to annual crops, may not be applicable for perennial crops and could cause incorrect conclusions. We recommend that such knowledge-intensive technologies should not be promoted as stand-alone technologies but rather should be complemented with infrastructural and institutional development if they are to achieve their intended primary objective of improving enterprise productivity.

Keywords: Adoption, endogenous switching regression, impact, Kenya, productivity, tissue culture banana

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Understanding Technology Uptake Processes: The Case of Improved Sorghum Varieties in Tanzania

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More than half of the population in Eastern Africa lives in extreme poverty. The incidence and severity of deprivation is highest in the less-favoured semi-arid areas that suffer from poor infrastructure and market access, infertile soils, and vulnerability to climatic variability. Although currently under-developed, dryland cereals remain the most cultivated food and cash crops for smallholder farmers. The crops are well adapted to marginal biophysical conditions and are grown by resource poor farmers (especially women) without requiring substantial external inputs.

Sorghum (*Sorghum bicolor* L.,), is a staple cereal, especially grown in areas with low rainfall and where poor soil fertility, soil acidity and aluminum toxicity are common. In addition to food and feed it is used for a wide range of industrial purposes, including starch for fermentation and bio-energy. Sorghum stover is a significant source of dry season fodder for livestock and it has good grain mold resistance and thus has a lower risk of contamination by mycotoxins. Despite the potential importance of sorghum in the region, the adoption of improved varieties is slow and some aspects of the adoption process remain poorly understood.

This article applies a programme evaluation technique to data from Tanzania to analyse the adoption processes and how social learning may lead a farmer's initial decision to adopt a new technology to be related to the decisions of others in his social network. We derive estimates of the actual and potential adoption rates of improved sorghum varieties and their determinants. The study reveals that only 49 % of the sampled farmers were aware of the improved sorghum varieties which consequently restricted the sample adoption rate of improved varieties to only 21 %. The potential adoption rate of improved sorghum if all farmers had been exposed to improved varieties is estimated at 42 % and the adoption gap resulting from the incomplete exposure of the population to the improved sorghum is 21 %. Social learning effects play a significant role in enhancing adoption.

Keywords: Adoption, social learning, sorghum, Tanzania

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Effectiveness of Agricultural Extension Programs in Desert Areas: Case Study of Sugar Beet Program in Egypt

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The Egyptian government has applied extensive programs for land reclamation as a strategy to meet rapidly growing demand for food. The public extension service has applied many programs to deliver technical support that is appropriate for the physical, financial and institutional conditions of the newly reclaimed lands. Sugar beet Program (SbP) is one of those programs, which is implemented in both old and new lands. SbP intended outcomes are improving Sugar beet Growers? (SbGs) knowledge and practices leading to increase production efficiency and profit. Nevertheless many studies have indicated that these programs are not effective. Furthermore most of these studies assess the impact of extension only on the adoption level, which is less informative regarding the applications? shortages and the environmental factors that could influence the program performance. The objective of this study is to elaborate our knowledge regarding the strengths and weakness of such programs according to when, where, and how such programs were planned, implemented and evaluated. These results could help policy makers to design more effective future programs. This study can be described as an ex-post assessment designed to explore the effectiveness of SbP, as a case study of the extension programs in the desert areas. A random sample was selected of 117 SbGs in Nubaryia region. All Extension Staff (ES) were involved in the study with a total number of 22. Three analytical procedures are applied: Path Analysis (PA) for exploratory purpose, Evaluation Logic Model (ELM) for model specification, and Content Analysis (CA) of 36 reports to describe the extension activities. The findings show that SbP had no significant impact on its intended outcomes. Regarding the ES qualifications and training, 72.7 % have a school education and surprisingly 18.2 % have non agricultural education. 90 % of the ES involving in writing reports regularly. The main limitations for this study are lack of information in the village level, and inconsistent data set as a result of the dissimilarity of the geographical administrative classifications among different governmental bodies.

Keywords: Agricultural extension, effectiveness, evaluation logic model, land reclamation, Nubaryia path analysis, sugar beet

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On-farm Participatory ISFM Evaluation Trials in South-Kivu (DRC): Can We Obtain High Quality Biophysical Data?

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Knowledge-intensive technologies such as Integrated Soil Fertility Management (ISFM) often face challenges of farmers' adoption in sub-Saharan Africa. Participatory on-farm trials are an attempt to bridge this gap between scientific research and farmers' preferences. Since 2008, several thousand farmers have participated in CIALCA (Consortium for Improved Agriculture Based Livelihoods in Central Africa) on-farm evaluation trials. Simple treatments were supposed to illustrate the additive effect of ISFM technologies. One of the aims was to collect biophysical data across a wide range of agro-ecological and socio-economic conditions, which is a unique feature of this approach when comparing it to other researcher-designed and farmer-managed trials. A multi-layer facilitation system of CIALCA agronomists and farmer advisors strived to assist farmers in trial installation, management and data collection in field books.

The objectives of this study were to assess the quality of scientific data collection and the influence of facilitation hereon. Fieldwork was conducted in South Kivu (DR Congo) from June-July 2011. A combination of quantitative and qualitative methods was used: (i) field book analysis; (ii) assessment of trial setup and management; (iii) questionnaire survey; and (iv) in-depth, semi-structured interviews with key informants.

Our results show that participatory on-farm trials can successfully deliver high quality biophysical data. 96 % of all field data books were returned to CIALCA agronomists. 90–100 % of all trials were correctly installed in terms of manure and fertiliser application and crop arrangement, whereas only 50–60 % of chosen plots were homogeneous due to land scarcity. Missing data was low in 74–96 % of the field books; only for 2nd legume yield data this proportion was smaller (47–67 %) because of excessive cassava shadowing. However, methodological challenges in ex post data quality evaluation remain. Moreover, the influence of facilitation on data quality is not yet well understood, *e.g.* poor facilitation seemed to increase correct trial installation. Further analysis must look into the influence of other factors such as education, and recalculation of the facilitation index. For future improvement of the approach, this study recommends to a) simplify data collection; b) decrease number of trials; and c) develop methods for systematic data exclusion.

Keywords: DR Congo, farmer survey, integrated soil fertility management (ISFM), participatory on-farm trial

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Social systems

Who Knows? Indigenous versus Scientific Knowledge about Local Forest Change Dynamics in the Zambian Copperbelt

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The issues of deforestation and forest degradation have gained new international attention because of its role in mitigating carbon emissions. REDD (Reduced Emissions from Deforestation and Degradation) has been proposed as a means to mitigate loss of carbon stored in forests. In Zambia a REDD scheme is now being initiated at national level with the intention to implement local level projects at a later stage. A successful implementation, among other things, rests on the ability to assess the rate of deforestation and forest degradation and to identify drivers causing forest carbon loss – both at national and local level. At local level, such information can be obtained from several sources. This paper explores the relationship between two of these sources in relation to forest change dynamics; indigenous and scientific knowledge. First, the paper investigates to what extent perception based data from household surveys concerning forest change correlate with time series remote sensing data for two forest transition locations in the Copperbelt in Zambia. It finds that forest loss estimates derived from perception surveys largely are in congruence with estimates based on remote sensing observations. The paper then analyses how various actors of local forest governance (local people, customary leaders and government officials) perceive the causes of forest change. It is found that actors hold quite different opinions about what drives forest change and rely on both scientific arguments as well as indigenous knowledge to substantiate their explanations. The paper brings to attention that both scientific and more context specific indigenous knowledge have roles to play in REDD implementation but also that both types of knowledge cannot be considered unbiased or discrete but are influenced by prevalent discourses as well as political interests.

Keywords: Forest, indigenous knowledge, politics, REDD, scientific knowledge

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Socioeconomic and Livelihood Impact of Invasive Species on Marginal Homesteads: The Case of *Aceria guerreronis* on Coconut Palms in India

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Alien invasive species are non-native organisms that occur outside their natural adapted habitat and dispersal potential. They are seen as a threat not only to biodiversity and ecosystems, but also to socioeconomic development, livelihood and human well-being. In India, the bioinvasion of coconut palms by an alien invasive mite species *Aceria guerreronis*, popularly known as 'Coconut mite' accounting for enormous economic loss was first noticed just before the start of the new millennium. Among the plantation crops, coconut (*Cocos nucifera* L.) is of prime importance in the marginal homesteads of tropical India. India is the third largest coconut producer with plantation area of 1.9 million hectares and estimated production of 12.8 billion nuts per annum. Coconut sector in India accounts for about 22.36 % of the world production while contributes approximately US $1600 million to the total GDP of India, besides providing livelihood securities to more than 10 million people in the country. Every part of the coconut palm is used and has found use in more than 700 products here. During the period 2001–02, mite attack has affected nearly 22.36 million coconut palms in 98,400 hectares in prime coconut producing state 'Kerala' in India. The percentage reduction in nut weight due to mite infestation was assessed to be 2.12 %. Mite damaged underweight and undersized nuts are often discarded by the traders inflicting heavy losses to the growers. Additionally, mite damage resulted in loss of 20-30% in terms of copra yield and also increased labour due to difficulty in de-husking of affected nuts. This paper hence seeks to study socioeconomic and livelihood impact of the coconut mite and also estimates the economic loss in monetary terms from documentary evidence. The present study estimates the control costs incurred by Indian government and various agencies to manage coconut mite in India from 1998–2008 as US $ 77.88 million. A gap analysis using sustainable livelihood index (SLI) framework of unpublished primary data collected during the peak year of infestation (yr. 2002) among coconut growing households [N=120] in two villages of Kerala showed a difference of 56.26 % between the potential and achieved livelihood impact.

Keywords: *Aceria guerreronis*, bioinvasion, coconut, India, invasive species, livelihood impact, socioeconomic impact

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Adaptable Livelihoods: Wild Foods, Resilience and Food Security in Rural Burkina Faso

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The dominant form of subsistence in rural Burkina Faso is a combination of crop production, livestock keeping and agro-forestry. This research set out to understand how rural populations choose their livelihood activities in order to maintain the flexible and resilient livelihood system which has allowed them to survive in the arid and highly variable climate of the Sahel for hundreds of years. The study was conducted over an entire agricultural cycle (Oct. 2009–Dec. 2010), within eight family compounds (containing 23 households). In addition to their own agricultural production, all families also bought food, gathered wild foods and received food from friends and relatives. Cultural norms and power relations played an important role, particularly in determining women's access to resources and men's aversion to credit. Nonetheless, these norms were regularly subject to re-negotiation within a household, thus endowing the livelihood system with flexibility. Conflicts of interest arising between individual household units and the larger family compound resulted in different families sharing resources to varying degrees. Compounds were found to merge and split again into individual household units during the year, balancing the costs and benefits of pooling resources from a larger group of people. The flexibility of household size which allows resources to be pooled at critical moments was found to be a successful adaptive strategy in such a marginal environment. Contrary to theory, diverse livelihood strategies did not necessarily confer livelihood resilience, but carried significant costs of labour and time. Most households exhibited a less diverse system which could be diversified at key points during the year, due to low barriers of entry and exit. This flexibility allowed short-term benefits of improving food provision to be weighed against any long-term loss in resilience, with a clear preference for sustainable long-term food security. It is important to demonstrate the nuances of adaptation over time (between seasons) and over scale (household and compound size) in order to better understand what drives resilience in marginal areas.

Keywords: Food security, sesilience, Sahel, seasonality

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Working Conditions of Self-employed Pastoralists and Employed Herders on Commercial Ranches in Northern Kenya

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Decent Work promotes opportunities for women and men to obtain decent and productive work in conditions of freedom, equity, security and human dignity. The aim of this study was to assess how livestock keepers in northern Kenya view their working conditions, and how they assess hardship and rewards in their daily work and their working life. Their perception is compared with ILO's concept of Decent Work.
Samburu pastoralists in Marsabit and Samburu district as well as herders on ranches in Laikipia district were interviewed. Semi-structured interviews (n = 30 pastoralists, 17 employed herders) were used to systematically record daily activities and to collect information about: income, freetime, education and social security. In open interviews 22 pastoralists and 13 employed herders told their life stories. Data were mainly analysed qualitatively using content analysis. Emphasis was placed on hardships and rewards and the reasons for the livestock keepers and herders' perception.
Pastoralists see it as important to have healthy and satisfied animals. Also the ability to provide food to the family members especially the children has a high priority. Hardships for the pastoralists are, if activities are exhausting (*e.g.* carrying heavy loads for long distances), challenging (*e.g.* digging water holes), dangerous (*e.g.* risk of getting hurt/killed), burdensome (*e.g.* disagreements). For employed herders decent conditions are if their wages are high enough to be able to provide formal education for their children and food for their family. It is further important to them to do work they are experienced in. Most herders on the ranch were former pastoralists, who had lost their animals due to drought, raid or disease.
There are parallels between the ILO 'Decent Work' concept and the perception of working conditions by pastoralists and employed herders. These are for example, that remuneration is of importance and the appreciation by the employer/the community is desired. Some aspects that are seen as important by the ILO such as safety at work and healthy working conditions only play a secondary role to the pastoralists, who see risky and dangerous tasks as part of efforts to gain a livelihood.

Keywords: Decent work, employment, Kenya, pastoralism, ranching, working conditions

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Households Migration Decisions in Rural Areas of East Java, Indonesia

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Labour migration is a process over which labour withdraws from one region to meet manpower demands in another region. In East Java migration is a wide-spread strategy used by rural households to allocate their labour resources among different areas, to reduce the livelihood risks and increase income.

This research aims to answer the question which factors determine the migration and the household decisions in rural areas of East Java Province. It tests the hypotheses that human capital, physical capital, social capital, government aids, farm characteristic, institutional characteristics significantly influence the decision to migrate abroad and to urban centres.

The New Economics of Labour Migration (NELM) is a theory which explains migration in the context of the decision making of a social group, either the family or the household. Based on this theory, the study which will be presented aims to analyse the determinants of rural-to-urban as well as international migration in Malang District, East Java Province, and, as a result, to identify factors, which are essential for the design of policies and programs aiming to promote rural development.

For that purpose, primary data were collecting in a survey in Malang District by using a structured questionnaire. The survey employed purposive and disproportionate stratified samplings of 360 respondents across 12 villages in the kecamatan (sub-district) Wagir. In addition, secondary data were collected from various statistical reports, in particular the Countryside Potency Data of East Java Province which came out from a survey carried out by the Central Bureau of Statistics in 7,677 villages in 2005.The data analysis was divided into a descriptive and an econometric part using probit and tobit estimation.

The study concluded that the strength of social relations and being a woman are factors which have a significantly positive influence on the probability to migrate abroad whereas marital status and numbers of children are not significant factors in the migration decisions. This study also proved that institutional factors *i.e.* market access, credit access and infrastructure specifically water resources have positive effect on rural households for detaining migration.

Keywords: Households, migration, rural areas

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Understanding Land Use Decision-making Using Bayesian Networks in Yunnan, China

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Strict enforcement of forest protection and massive afforestation campaigns contributed to the significant increase in China's forest cover during the last 20 years. At the same time, demographic changes in rural areas due to changes in reproduction patterns, the emigration of younger population segments as well as an increasing availability of off-farm employment pulled people away from agriculture. Concurrently, farmers frequently switched to less labour intensive agricultural activities such as the plantation of trees on former cropland to produce cash crops or timber.

We identified the proximate factors and underlying causes that influence the decisions of farm households to plant trees on former cropland with Bayesian networks (BN). BNs allow including causal relationships in data analysis and can combine qualitative stakeholder knowledge with quantitative data. We defined the structure of the network with expert knowledge and in-depth discussions with land users. The network was calibrated and validated with data from a survey of 509 rural households in two upland areas of Yunnan province, southwest China. The two study sites exhibit high poverty incidences and experienced large deforestation rates on sloping lands that led to severe soil erosion and water runoff.

Results substantiate the influence of land endowments, labor availability, off-farm opportunities and forest policies for switching from cropland to tree plantations. Moreover, ethnicity and education are strong predictors of the decision to plant trees by forming land use traditions and shaping access to information. The thorough causal understanding of land use decision-making allows us to explore various scenarios such as the effect of an ongoing decrease of the rural labour pool and of agro-environmental policies with improved spatial targeting. In that way, we contribute to a better understanding of local forest transitions and identify sustainable development pathways in poverty-stricken mountainous areas of China.

Keywords: Bayesian belief networks, decision making, forest transition, land use change, Yunnan

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Setting up Collective Banana Marketing in Central America: The Role of Social and Human Capital

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Collective marketing is often seen as the pre-condition for small-scale farmers to access profitable value chains or to increase their benefits from commercialisation. Market studies for bananas grown by smallholders in agroforestry systems with coffee in Central America show that options for upgrading value chains exist *e.g.* with supermarkets or in the domestic tourism sector. However, continuous harvest throughout the year and perishability of bananas constitute particular challenges for organising marketing. This study focuses on the relevance of farmer groups' endowment with human and social capital during their pre-start phase of marketing by analysing the situation of four farmer groups in Nicaragua and Honduras. Data was collected through qualitative interviews with farmers and representatives of local service providers using participatory research methods. Relevant factors for collective marketing were identified and the farmer groups' potentials and their need for external support was determined.

The analysed farmer groups differed in their resource endowments: One group already owned banana storage and packaging facilities, but low levels of trust impeded their use. In the group with the highest motivation, the existence of *Fusarium* Wilt disease posed a constraint. Two other groups had low endowments with social capital, but were advantaged through their natural resources. Results showed that for successful collective banana marketing, farmer groups' high motivation and trust, risk awareness and access to external support in organisation, plant management and marketing are important. Long-term support is very likely to be necessary.

Based on this analysis, collective marketing cannot be recommended as a generally superior strategy of improving income from commercialisation. For groups with high social capital, the further exploration of alternative markets, the development of specific marketing strategies and the identification of external support available are the first steps for strengthening the organisation and enabling a successful start-up. For groups with a lower endowment of social and human capital, upgrading through higher volumes, improving quality and gradually increasing coordination in marketing with comparatively low levels of formality is likely to be the most viable option in the short and medium term and could be a starting point for building a better resource base.

Keywords: Bananas, Central America, collective action, marketing, social capital

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Coffee Farmers' Cooperatives as the Basis of Coffee Certification: A Comparative Study in Ethiopia, Nicaragua, and India.

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Coffee is a strategic product in many developing countries. Millions of smallholder farmers in remote and underdeveloped areas of developing countries depend on coffee production and marketing as their primary source of cash income.
Product certification is a standardised market tool to add value to a product. It addresses a growing worldwide demand for healthier and more socially and environmentally-friendly produced products. The certification of coffee is increasingly promoted by donors, NGOs, and state agencies to provide poor smallholder coffee farmers with better livelihood opportunities. Fairtrade and organic are the most widely used certification standards in this regard.
Smallholder coffee farmers in developing countries, however, can only be certified if they are organised in local coffee cooperatives or other formal organisational entities that comply with the respective standardised certification requirements.
While certification is a standardised instrument applying the same standards for all coffee farmers' cooperatives worldwide, the history, structure, and characteristic of the cooperatives themselves is highly contextual and hence diverse. This is mirrored in their different organisational, material and human capacities and resources and their different positions in the local, national and international coffee markets and value chains.
This paper argues that the impact of coffee certification depends more on the capacities and performance of the local coffee cooperatives that on certification as such. Positive characteristics of a cooperative, such as strong organisational structures, good management skills of the decision-makers or the active participation of the members are overall important to establish cooperatives as independent and strong market actors and to provide the cooperative members a better income in the long term. In this context certification can contribute making 'good' cooperatives better but not turn 'bad' cooperatives in 'good' ones. This argumentation is based on empirical findings from field research conducted in 2009/10 in coffee cooperatives in Ethiopia (Jimma), Nicaragua (Jinotega), and India (Araku Valley). A total of 750 interviews were carried out with members of cooperatives that are certified according to Fairtrade and organic standards and members of non-certified cooperatives. Additional open interviews were conducted with experts concerned.

Keywords: Certification, coffee, cooperatives, Ethiopia, India, Nicaragua

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Community Forestry Governance in Nepal: An Analysis from Central to Local Level Stakeholders

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Community Forestry (CF) programme in Nepal has been widely recognised as a successful model for decentralisation and devolution of power to local communities in order to manage their community forests and fulfil their forest products needs. Community Forest Users Groups (CFUGs) are the key implementers who protect, manage and utilise community forests in a sustainable basis. Despite of many successful stories, several issues and challenges have been emerging among them good governance is one of the key concerns in community forestry. Several government and non—government organisations are working with Community Forest Users Groups in order to ensure community forestry governance. Several problems related to good governance have been realised at policy makers, service providers and CFUGs level. Whether they are practicing good governance in their own level or not is still quizzical to the public. This paper explores and analyses the community forestry governance at two levels: a) national level for policy makers and service providers, and b) Community Forest User Group level. It tries to come across the main achievements and challenges of community forest governance using five major characteristics of good governance: transparency, accountability, participation, inclusion/equity and rules of law. The study is based on qualitative and quantitative data. At the national level, interview was carried out with forestry experts working in governmental and non-governmental organisations and with the donors who are supporting community forestry programme in Nepal. Quantitative data were analysed using Statistical Package for Social Science. The findings reveal that community forestry policies are formulated in a participatory manner at national level, albeit there is a need of building an environment for effective coordination, mutual trust and partnership among the stakeholders,*i.e.*, policy makers, service providers and donors. At the CFUGs level, they have been functioning independently but the limited users especially elites and committee members are exercising the power of the whole group, while women and disadvantaged groups are not getting the benefits as expected. It has been concluded that rigorous effort is still necessary to improve the governance both at central and local level and within the CFUGs.

Keywords: Accountability, community forestry, equity, governance, participation, power, stakeholders, transparency

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Local Soil Knowledge in Vietnam's Northern Mountainous Region: A Case Study among Different Ethnic Groups

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In the last decades the world-wide demand for agricultural products increased strongly caused by population and wealth increase. Due to its rapid growth of population and economy within the last 20 years Vietnam is a good example for this process. Agriculture was intensified and expanded into fragile agro-ecological areas like the northern mountainous region (NMR) involving soil degradation by erosion and depletion as well as deforestation. The greater part of the population there belongs to ethnic minorities. They live mainly from farming and rank among the poorest people in Vietnam. So they are hit hardest by the mentioned problems.

Local soil knowledge is seen as a key factor to develop sustainable agriculture. Therefore this study is supposed to figure out the local soil knowledge among different ethnic minorities in Son La province in NMR. Six villages in Yen Chau district were selected, two of them inhabited by H'Mong minority, two by Black Thai, one by both, H'Mong and Black Thai, and another by Black Thai and Kinh majority. For all villages socio-economic and pedological data were already available from subprojects of the SFB 564 (Sustainable Land Use and Rural Development in Mountainous Regions of Southeast Asia). The socio-economic data was used to figure out influences to local knowledge like ethnicity, access to markets, education or wealth. The pedological data will help to explain local soil types and their properties from the soil-scientific point of view.

The local knowledge was collected by workshops based on "Participatory Rural Appraisal". In each village one workshop was held which was split in three parts: the first with older farmers, the second with younger farmers and the third as combination of both groups with discussion of the results, creating a local soil map and a transect walk. This should reveal the knowledge flow within the villages and the impact of events during the last decades.

By this methods the soil classification system of the people in the NMR, reasons for their classification, its impact on their farming and their awareness of impacts of land use intensification on soil properties and productivity were analysed.

Keywords: Ethnopedology, local knowledge, Vietnam

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Transactions and Institutional Arrangements in Oil Palm Production Promoting Land Conversion and Deterioration of Rural Livelihoods in Indonesia

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The expansion of oil palm cultivation by smallholders is increasingly taking place at the interface between the forest and farming land in Indonesia. The decision of smallholders to convert land into palm oil plantation establishes a long term path dependency with many implications. This paper aims to analyse how transactions among actors involved in oil palm production and market influence decision making of smallholders to convert forest and farmland into oil palm plantations; and to analyse the impact of the current institutional arrangements on the livelihood of the smallholders as well as food supply in rural communities. The finding is that land conversion undertaken by farmers is not only determined by the determinants related to land use, but in fact it is also strongly shaped by institutions and governance on oil palm market. By means of the prevailing institutional arrangement and smallholder's production pattern, growing palm oil does not improve the livelihood of smallholders and even endangers the food supply for household consumption as well as rural communities. Therefore, improving the institutional arrangement at the product market is necessary to be performed to enforce the minimum quality standard of oil palm fruit. We argue that improving the institutions and governance at the buyer level (mills) is a crucial point and presumably realisable in order to endorse the middlemen to apply standard sorting and furthermore encourage or urge farmers to devote their resources to improve the productivity rather than expand the plantation. By increasing the quality of product presumably could promote the sustainability of farmer's livelihood as well as hold the farmland and forest conversion.

Keywords: Farmland and forest conversion, governance, institutions, livelihood, oil palm

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Determinants of Collective Marketing Performance: Evidence from Kenya's Coffee Cooperatives

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In Kenya, coffee produced by smallholder farmers is marketed through farmer-based coffee cooperatives. Since the liberalisation of the coffee sector, coffee cooperatives can choose a market outlet and negotiate prices with their buyers, however, very few have made use of these new market opportunities so far. Relying on collective action theory this paper analyses the performance of Kenyan coffee cooperatives using a random sample of 120 coffee cooperatives in Central and Eastern Province that were surveyed in early 2011. Performance is measured in two different dimensions; firstly, in terms of the average amount of coffee delivered to the cooperative by its members. The ability of the cooperative to attract larger volumes of coffee from individual members is expected to be a function of the extent and quality of services and inputs supplied by the cooperative. Secondly, we use the average coffee price paid by the cooperative to its members as a performance measure. Higher prices paid to farmers are assumed to reflect better marketing and management skills of the cooperative.
Our results show that in 2009/2010 cooperatives received an average of 312 kg (S.D. 138) of coffee per member and paid an average of ksh 48.2 (S.D. 14.14) per kg of coffee. The standard deviations reported in brackets indicate that there is substantial intra-cooperative variation. The main factors explaining the performance of cooperatives identified in our econometric analysis include indicators that reflect: (i) the alignment of members' goals with the goals of the cooperative and the prevalence of free riding, (ii) problems of mismanagement at the management level of the cooperative as measured by incidences of corruption, and, (iii) the transparency and stability of the cooperatives' marketing strategy. Finally, this paper examines the importance of voluntary formal control mechanisms in reducing problems of free-riding, corruption and lack of transparency in Kenya's coffee sector. We conclude our paper with implications for public sector interventions that can help to facilitate collective action.

Keywords: Coffee cooperatives, collective action, corruption, free riding, Kenya, marketing performance, transparency

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Stakeholders, Interests and Power as Drivers of Community Forestry: Case Studies from Ecuador and Peru

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This analysis comprises two community forestry (CF) cases: the first one corresponding to a Shuar Centro in Ecuador, and the second to an Asháninka community in Peru. The analysis focuses on the stake holders, their interests in CF and their power. Additionally the outcomes of CF are examined. The applied network analysis makes power networks pertaining to community forestry visible. A three dimensional power model developed by Hasanagas (2004) was used. This model operationalizes power as coercive trust, liberal trust and incentives. In addition irreplaceability gives to a stake holder high power due to a specific situation. Finally, for assessing the outcomes of CF, the study evaluated indicators of sustainability classified in economic, ecological and social dimensions.

By evaluating the CF networks of both case studies, similarities in terms of network size and composition were found. Communal, governmental and aid actors occupy central positions in both networks. In the case study of Ecuador, the power is predominantly focused on communal actors while in the case study of Peru governmental actors hold the greatest power. In both case studies, communal actors, who have the right to use the forest resource, as well as the government actors, responsible for issuing permits for the harvesting and marketing of forest resources, are irreplaceable in their roles within the networks. The aid actors, which are seen as trustworthy institutions and as maximum providers of incentives, play a leading role in the implementation of CF.

Assessing the outcomes of CF by evaluating social, economic and environmental indicators, overall positive results in both case studies were found. In both cases, communal forest enterprises are important for generating social and economic benefits, as well as in for implementing sustainable forest management. In the case studies of Ecuador and Peru the legal framework that regulates the access to forests is also crucial in the level of benefits that different actors may obtain from CF.

Keywords: Community forestry, networks, power, stakeholders

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Agricultural Marketing Cooperatives as Laboratories of Social Innovation: Establishing Cooperatives among Ethnic Smallholders in Thailand

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Cooperative organisation has long been an approach to improve the socio-economic conditions of its member-farmers, and has been described as a promising scheme particularly for linking smallholders to credit and supply markets and to facilitate access to outlet markets. The basic advantage to serve the needs of its members rather than generate profits for investors - as it is the case in ordinary business enterprises- entails what pioneers in this academic field coined "the dual nature" of cooperatives, highlighting the cooperative a) as a social group and b) a joint enterprise, owned and operated by the same members of the group. However, recent changes in food markets and emerging consumer needs require increasing innovative abilities of the farmer groups and a strong identity at the same time.

Against this background and in order to largely unfold its advantages, a cooperative will inevitably have to undergo a process of formation and standardisation, and it is likely that the group will face problems which pose a threat to its very basic cooperative set-up or eventually to overall continuation.

The study will initially revise these bottlenecks from literature and - departing from this - analyse the peculiarities the establishment of two cooperatives among ethnic Hmong upland farmers brought out, focusing on the formation of group internal structures and the loci of decision-making. Thus, the paper will key in current discourses on community-empowerment and pro-poor approaches to development.

Drawing on the experiences from a 5-years action research project into the establishment and facilitation of agricultural marketing cooperatives in ethnic smallholder litchi production, the data basis this analysis is build on consists of 14 consecutive protocols of group leader meetings since this institution's implementation, supplemented with participant observations that were recorded in a structured form.

The results will provide insights into what specific pitfalls can be expected in embedding cooperative organisations among ethnic farmer communities, and how these pitfalls can be anticipated and overcome. We examine the boundaries of cooperation in the ethnic smallholder context and highlight the factors favouring a clear delineation from private business approaches, enabling a maximum participation of local smallholders.

Keywords: Agricultural Cooperatives, ethnic smallholders, qualitative research, Thailand

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Public Participation in Environmental Management: Joint Forest Management in Developed and Developing Countries - A Review

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Public participation is a process-oriented activity. It is a two way process, where both the agency and the public can learn and gain the benefits and is viewed as a movement to attain equity and sustainability in environmental Management. The Secretary's of public participation policy Statement defines public participation as "open, ongoing, two-way communication, both formal and informal, between government and its Stake holders-those interested in or affected by its actions" (USDE, 1998). World Commission on Environment and Development (1987) defines Environmental Management as "the field that seeks to balance human demands upon the earth's natural resource base with the natural environmental ability to meet these demands on a sustainable basis". The objectives of the paper are, to study the concepts and models of public participation in environmental management and to know the public participation role in Forest Management through review the case study of developed and developing countries.

The Present paper attempted to spotlight the notion of Public participation in Environmental Management. In this Globalized Era, it is crucial that, we compare, exchange our views and experiences of public participation across the continents. The case study from India on Joint Forest Management as a case study from developing country and Joint Agency-Public (community) decision making from (Queensland parks and wildlife service) from Queensland as a case study from developed country are reviewed focussing the objectives of the paper. The study has come up with meaningful conclusions and recommendations. Increasing the social responsibilities for local governments and on the Public is an important part in achieving success in environmental management through public participation process. At the outset, public participation in environmental management is vital to strike a fundamental chord in assessing democratic governance for the sustainable success of the programmes in the present and for the future.

Keywords: Environmental management, India, joint agency-public, joint forest management, public participation

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The Common Good for the Few: Double Marginalisation in Ethnic Minorities in Vietnam

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In countries where the majority of the population is comprised of one ethnic group, the remaining minority communities can remain or become further marginalised when the benefits of development projects accrue to the elite of the dominant ethnic group. This paper examines Vietnam's ethnic minority communities who live in such marginal situations. Since d*oi moi* (renovation) in 1986, an array of policies, programmes and projects have been implemented to empower people, in particular ethnic minorities. Despite applausive achievements especially in poverty reduction, ethnic minorities continue to be poorer and more disadvantaged than the majority Kinh community, elucidated by the lack/lower return of endowments and/or community characteristics. This paper focuses on the relation between internal community structure and power relations, and development outcomes on ethnic minority villagers. Three case studies covering two of Central and Southern Vietnam's most underprivileged ethnic communities – the Pahy and the Khmer – are examined. Ethnographic field research was conducted in July 2010 in Thua Thien Hue Province and March 2011 in the Vietnam's Mekong Delta. In Rum Soc Village the case of the agricultural club illustrates how Kinh managers prominently represent and make decisions for the majority of Khmer farmers. The development story in Tri Ton District presents a contrasting picture of two neighbouring Khmer villages: while one village became a regional "model" of development through a disproportionately large receipt of knowledge, technology and financial transfer, the neighbouring "normal" village continues to confront harsh modern-day challenges with their backward farming techniques. Finally, Khe Tran Village provides a good example of the momentous changes brought about by 20 years of governmental projects, yet close investigation reveals that the beneficiaries are just a few powerful Pahy-Kinh households with the majority lagging behind.

The paper substantiates that the benefits of development projects, in the name of the common good, are reaped by just a few powerful elites. Poorly designed and monitored development interventions that ignore power relations and are biased in their beneficiary selection vigorously back up and strengthen the local-level structural power inequity. This pushes ethnic minorities to the second layer of marginalisation.

Keywords: Community development, development interventions, ethnic minorities, Khmer, marginalisation, Pahy, Vietnam

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Improving Benefits from Marginal Lands: Contribution of Homegardens to Household Income Generation

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Rapid population increase usually results in land fragmentation, over cultivation, reduction of soil fertility and hence poor yields of farms. This exploratory research was conducted to study the contribution of homegardens to household income generation and identify arguments to improve income generation. In Burkina Faso the Bieha district was purposively selected for the study. The initial Rapid Rural Appraisal was complemented by a household survey. Tools of data collection included techniques such as; transect walk, personal observation, key informant interview, and focus group discussion. For the survey, eighty households were selected based on systematic sampling. Data was collected by individual interviews at household level, and for statistical calculations, the households were subsequently categorised as small, medium and commercial based on the size of their homegarden. It was found that all the surveyed households manage homegardens composed of trees, food crops and animals. In terms of homegarden importance to households, 42 % of all respondents said extremely important, 43 % said important while 15 % said not so important. Generally, farms were found to contribute more income than the plant component of homegardens. However, when the livestock component of homegardens was added, homegardens became far more important than farms and accounting for over 60 % of income generation for all categories. Majority of the farmers (43 %) belonged to the small category due to land constraints. Ensuring global food security requires the improvement of intensive production systems such as homegardens which can be practised on marginal lands successfully. It was found that homegarden inputs and outputs increased significantly as homegarden size increased. Small homegardens were found to have the highest input and output per unit area.

It can be concluded that homegardens are very important for food and cash income in this area of marginal lands. Small homegardens record high output per area due to intensive management and hence farmers should be encouraged to also intensively manage their large farms to maximise income generation. The adoption of this type of agroforestry on marginal land can significantly improve income generation by diversifying income sources.

Keywords: Agroforestry, homegarden, household, income, land fragmentation, population increase

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Analysis of Household Specific Transaction Cost Factors in Livestock Input Markets in Ethiopia: Implications for Private Sector Development

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Ethiopia has the largest livestock population in Africa. Yet, Livestock productivity is among the lowest in the region. Several factors contribute to the low productivity, including inefficient input and output markets, diseases and traditional management practices. Improving the efficiency of livestock input markets is essential to raise productivity. High transaction costs reduce market efficiency and thereby the volume of exchange. Transaction costs are conditioned by the institutional environment in which exchange takes place. This study is conducted on 1200 households in 10 districts in 4 regions of Ethiopia to analyse household specific transaction cost factors in livestock input markets (feed, veterinary service and drugs, and artificial insemination (AI)), and the determinants of household participation in the input markets. Highest input market participation is observed for veterinary services and drugs, followed by roughages and agro-byproducts. Household market participation in concentrates and AI is very low. Household wealth appears to be an important determinant of participation in livestock input markets. Households perceive high degree of cheating on quality and weight of inputs by traders. Similarly, households are concerned about information asymmetry when inputs are bought from traders, as opposed to farmers. Our results show that transaction costs are of high concern for farmers when inputs are bought from the private sector. The involvement of the private sector in livestock input markets must be encouraged in Ethiopia. However, our results imply that policies and strategies to promote the involvement of the private sector in livestock input markets need to be accompanied by appropriate regulatory system to mitigate the effect of transaction costs.

Keywords: Input markets, livestock, transaction cost, transaction cost factors

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The Nexus between Poverty and Smallholders' Investments in Agroforestry: A Case Study from Tanzania

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Environmental degradation and poverty of rural households are closely linked in developing countries particularly in Sub-Saharan Africa. The majority of the rural poor derive a high share of their income by extracting natural resources *e.g.* firewood and timber from forests. In the course of environmental degradation and the awareness about scarce natural resources special emphasis is given to the protection of high valued areas such as forests. As a consequence, the integration of agroforestry on smallholders' plots gained centre stage in recent years providing new income possibilities as well as a promising solution to alleviate soil erosion on agricultural plots which helps stabilising yields.

Tree cultivation on farms implies an environmental long-term farm investment, where the individual time preferences paraphrased as individual future evaluation is argued to play a significant role in. Yet, there have been only a few empirical studies assessing the rates of time preference among rural poor in the nexus with environmental conservation measures, *e.g.* Holden et al. (1998) with regard to investments in soil conservation technologies, but no study is known to the authors with respect to agroforestry.

This paper aims to analyse the nexus between poverty and smallholders' long-term investments in tree cultivation considering their future evaluation. The analysis is based on a data set compiled using household survey data from a village located in the Uluguru Mountains in Tanzania in 2010. Tree density, wealth and the present value are significantly positively correlated. In the regression on tree density, the estimated coefficient for time preference is highly significant. If the present value – the proxy for time preference - increases by TZS 1889 (= €1) the tree density increases by 1.13 %. A low present value implies that the poor are less likely to invest in environmental conservation measures than the rich.

Keywords: Agroforestry, environmental conservation, poverty, time preferences

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Joint Elicitation of Preferences and Perceptions among Small-Scale Farmers in West Africa

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In any development intervention aimed at reducing poverty and vulnerability, potential benefits and costs associated with a new technology or policy are both stochastic and dynamic. In effectively designing and implementing those interventions it is necessary to understand behavioural responses of target beneficiaries to uncertainty and time. The joint elicitation of risk and time preferences provides behavioural information and contributes to some extent to the understanding of the underlying decision-making process.

This study presents an advanced methodology of jointly eliciting attitudes towards risk and time and the subjective perception of uncertainty among an identical sample of 200 smallholder cattle farmers in the cotton belt of West Africa. The sample had been randomly selected from a common intersection of previous socio-economic survey samples in 2003/2004 and 2007 in the study area. All farmers face the problem of managing a major livestock disease, *i.e.* African animal trypanosomosis (AAT) in cattle and its widespread resistance to commonly available drugs. Because of the dynamic nature of the disease and its strong interdependency with farmer's behaviour and perception of uncertain events it is useful to expand the measurement of risk attitudes and simultaneously elicit farmers' time preferences and subjective probabilities of cattle's health states.

In total, five field experiments had been conducted during January and February 2011 in the study area common to southwestern Mali and southeastern Burkina Faso. Subjective probabilities had been inferred by asking the farmer about their probability judgment of uncertain events taking into account stochastic dependency. Moreover, three risk experiments of different designs had been conducted in order to expand the measurement of farmers' risk preferences beyond the concavity of the utility function, and to put the respondent into the concrete management problem of disease treatment and prevention within a dynamic set up. The time experiment had been designed in the way to test several forms of discounting.

A first rapid assessment of this data set shows that respondents are less risk averse and more patient than general premises about risk and time preferences among rural poor suggest.

Keywords: Dynamics, experiments, risk preferences, subjective probabilities

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The Contribution of Forest Resource Use in Rural Poverty Dynamics

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Large number of people around the developing world lives with abject poverty of which rural areas account the lions share. Combating poverty has been, thus, the major agenda of most international and regional conferences and declarations. But, the role of forests has still been ignored in many of the discussions and no study has been yet undertaken on the contribution of forest resource use to rural poverty dynamics even though forests are potent to help the rural poor to escape from and mitigate poverty. The scholarship on the contribution of forests has, thus, lagged behind and forests have not been given academic emphasis as what they should deserve. Therefore, based on a two wave panel survey of about 321 households from rural Nepal, data from PEN (Poverty and Environment Network), the study examines the role of forests to income poverty transition. Poverty Transition Matrix (PTM) and Ordered Logit Model (OLM) are used to analyse the data.

The findings from the PTM reveal that forests have a role to help households to escape from poverty and prevent them from moving in to poverty. The OLM hosted a wide range of explanatory variables and tested for econometric problems of Multicollinearity, Hetroscedasiticity and attrition. The Endogeneity of the major variables of the study *i.e.* forest resource uses were also tested and we found no evidence for Endogeneity. The results of the model highlighted that change in the use of fuel wood and forest wage are the main forest resource use factors that enhance up ward poverty transitions in terms of quartile movements. Other factors, such as debt, number of economically active household members, forest user group (FUG) meeting attendance, and change in remittance, do also enhance households' up ward income quartile movement whereas change in number of dependents and households' engagement in costly social events are the two major factors that enhance downward quartile movement. Hence, the government shall do in line with forest resources and other factors that enhance households' welfare to reduce poverty and to develop effective conservation policies.

Keywords: Forest resource use, poverty dynamics

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Socio-economic Factors and Garden Size Affect Plant Species Richness and Diversity of Homegardens of the Nuba Mountains, Sudan

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Biodiversity can have a positive influence on agro-ecosystem resilience and productivity. Homegardens are claimed to harbour a particularly high level of agrobiodiversity, but little is known about how market-orientation may reduce their plant species richness and diversity in arid and semi-arid regions, particularly of eastern Africa. This study therefore aimed at an inventory of plant species in homegardens (locally called 'jubrakas') in the Nuba Mountains, Sudan, and to assess socio-economic and structural factors determining plant diversity with a special focus on fruit tree species (FTs). In 61 randomly selected homegardens of four villages, richness and abundance of all useful plant species (excluding ornamentals) were recorded and diversity indices calculated. Gardeners were interviewed about their uses of plants and to gather basic socio-economic household data. Multiple regression analysis was applied to detect factors influencing plant diversity. A total of 111 plant species were grown in the homegardens, of which 53 were ligneous. Thirty-two FTs were cultivated for their fruits, including 24 indigenous species. Mean species richness was 23 per garden (range 6–47) including 5 FTs. Mean Shannon index was 1.45 (range 0.49–2.41) and mean evenness 0.48 (range 0.15–0.85). Species richness was sinificantly higher in market-oriented than in subsistence gardens ($p = 0.047$) while Shannon diversity and evenness was similar. Gardens of the indigenous Nuba people had slightly higher species richness, but significantly lower diversity and evenness than gardens of non-Nuba households ($p = 0.009$ and $p = 0.004$, respectively). Regression analysis indicated that garden size affected species richness positively, but evenness negatively. Also market orientation had a positive influence on species richness. Location of the four villages played an additional important role; higher diversity and evenness were found in the village with the best market access as compared to the most remote village (t-test; $p < 0.001$ for both variables). In conclusion, market-orientation had no negative effect on richness and diversity of useful plants in the surveyed homegardens, while market access, ethnic group and size of the garden significantly effected species diversity.

Keywords: Agroforestry, evenness, fruit trees, Jubraka, Shannon index

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(No) Future for Rice in Wayanad: Exploring the Social-ecological Transformation Processes and its Impacts on Marginalised Farmers in South India

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Agrobiodiversity is a complex resource that demands the interaction of actors and environmental resources for its maintenance. It is understood as the part of biodiversity involved in agriculture and food production. The decline of agrobiodiversity on a global level is linked to the loss of ecological knowledge and decreasing food security on a local level.

This research examines the social-ecological impacts of land use change at the case of rice cultivation in Wayanad, Kerala, South India. Wayanad district – the land of paddy fields – is an ecological and cultural (bio)diversity hotspot in which around 17 % of the population belong to tribal communities who have traditionally been involved in rice cultivation systems. However, changes in land use associated with the replacement of traditional rice varieties by banana and other cash crops as well as real estate modify agricultural systems and affect small scale farming communities. This results in the loss of crop related diversity on the one hand and the loss of local agricultural knowledge on local rice systems on the other.

The interdisciplinary research aims to investigate the social-ecological linkages of agrobiodiversity at the case of paddy cultivation in Wayanad. We are particularly interested in social-ecological changes happening in tribal community hamlets and how these influence agrarian relations and the agro-ecosystem as a whole. In order to grasp the complexity of agrobiodiversity, we argue for the need to foster interdisciplinary research and integrate insights from both ecology and rural development.

Two main research interests are at the centre of this inquiry: first, ecological knowledge and management practices and second, the multiple meanings of social-ecological transformation processes in Wayanad district in Kerala. Data were collected in three tribal communities in three different geographical locations. Thereby, we describe the interdisciplinary research process while focusing on the research design, participatory mapping and interview techniques as well as preliminary results. This research offers an initial response to social-ecological uncertainties which marginalised farmers currently face in Kerala.

Keywords: Agrobiodiversity, India, land use change, participatory methods, rice, social-ecological research, tribal communities

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Determinants of Farm-household Income in Marginal Areas: The Case of Rain-fed Farms in Pakistan's Punjab

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Agriculture is the backbone in Pakistan's economy. In 2009–10 it contributed 21 % to GDP, employed 45 % of its labour force and provided essential raw material to agro based industry. Moreover agricultural food products accounted for nearly 17.2 % of the country's export earnings. Agricultural growth has historically played a major role in Pakistan's development and continues to be crucial for economic growth, poverty alleviation and development. The continuous increase in the population on the one hand and stagnancy in agricultural production on the other hand have resulted in a gap between requirements for agricultural products and supply. Natural resource degradation and cyclic drought attacks play an important role in the low productivity of farming, in particular on small farms in rain-fed areas. The gap between the potential yield of major crops on experimental fields of research institutes and actual yield at farmers' field is wider in the rain-fed areas as compared to that in irrigated areas.

Against this background, the study which is presented explores the reasons for the low productivity of rain-fed agriculture in Pakistan, focusing on the determinants of the overall farm income in rural households. The field research was conducted in the rain-fed areas (Pothwar plateau) of Punjab province of Pakistan, in the districts of Rawalpindi and Chakwal. Primary data of 210 farm households were collected by personal interviewing, using a structured questionnaire.

The data were analysed by employing a log-log multiple regression production function through Ordinary Least Square (OLS) method to find out the determinants of the farm income. The results show that operational land holding and cropping intensity are inversely proportional to per hectare farm income. The area irrigated; the area under major crops and fodder crops; the number of livestock; cost incurred on livestock; hired labor; and tractor ownership show significant positive effects on farm income. Farm income of the household can be enhanced by employing improved production technologies through affective research and extension coordination.

Keywords: Household, income, marginal areas, Pakistan, Punjab

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Structural Configuration and Functional Dynamics of Kerala Homegardens in South India

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Homegardens in Kerala represents a subsistence land-use system typical of tropical Indian South, where interaction and intimate association of different production components (crop-tree-animal mix combine) insitu are intensively facilitated and managed by family labour so as not only to meet the food production but also to generate additional income through sale of farm surplus. This interaction and intimate association makes it ever evolving and adds significance to the structure of homegardens. Unlike the other land use systems, homegardens exhibit varying dominances and great diversity of species with many life forms. In such a system, structurally dominant crop component need not be economically dominant or technology needy whereas a transient crop which is numerically and economically dominant need not be structurally dominant but technology needy. Towards understanding more, 208 homegardens of South Kerala was studied using multi-stage stratified random sampling technique. The structural configuration was identified using the measure of Shannon and Wiener diversity index, Margalef's species richness and Pileou's measure of evenness. The structural, numerical and economical dominance was developed. The technology needs were inferred under four criteria employing Kruskal - Wallis test. Primarily a system with dominance was developed derived from diversity index, species richness, evenness and measure dominance. Biodiversity varied in homegardens within regions (mid region in case of all districts had the highest biodiversity), within and between districts, but was not influenced by holding size. Ten major dominance systems and eight specialised homegardens were identified. 3–4 of eight dominant components contributed significantly to annual homegarden income with varying contributing component. The highest needs for technology were recorded for under and unexploited horticultural tree crops. To conclude, the effect of zonation and variance of structure implies that the match between the variation in priorities of the home and the spatial arrangement of the homegarden was strong both socio-economically and bio-physically. Increase in population, emerging nucleotide family structure and high rate of fragmented holdings year round leading to decreased land for agriculture raises the conservation status of these land-use systems and makes it necessary for a 'homegarden policy' in regions where they are found.

Keywords: Functional dynamics, homegardens, India, structural configuration

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Protected Area Governance: Lessons Learned from NGO Endeavours in Nech Sar National Park, Southern Ethiopia

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The Ethiopian Government and the international non-governmental organisation African Parks Network (AP) signed an agreement in 2004 to hand over the management responsibility to the latter for 25 years. The agreement foresaw resettlement of those local communities who live inside the park area to outside its boundaries. However, after only three years, AP totally withdrew from Nech Sar National Park and left Ethiopia. This research illustrates and analyses governance of the park with a focus on the engagement and failure of AP. This allows learning lessons for national park governance in Ethiopia and beyond. Empirical data was collected from May 2010 to March 2011 through review of secondary sources, participatory mapping, group discussions, observations and key informant interviews. Additionally, officers and experts who worked at different positions for AP as well as government authorities were interviewed. Data shows that AP's activities were stopped due to a combination of factors: problems in engaging government actors; exclusive negociation with people who live in the park for boundary re-demarcation as a solution to the long-time controversial resettlement question; political sensitivity of the park management due to its location in the area where two regional states share boundaries; and lack of common understanding or formal agreement on timing of actions in effecting the responsibilities of both the government and AP. As it had been the case, during the three years of AP engagement in Nech Sar National Park, the natural resources of the park were also continuously degraded by cattle raising, illegal wood collection, fishing and crop farming. The paper hence argues that beyond technical and financial capacities, transparent cooperation and trust between state bodies on different administrative levels as well as NGOs and local communities are of utmost importance to sustainably govern national parks in Ethiopia and elsewhere.

Keywords: African Parks Network, natural resource conflicts, park governance

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Resource use and services

Ecosystem services and biodiversity

Neotropical Palm Products - Underutilised Ressources for Marginal Lands

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Tropical rain forests are known for their extraordinary biodiversity, but also for their generally poor long-term prospects as productive agricultural land. Deforestation usually leads to a rapid loss of soil fertility and rain forests are mostly agricultural "marginal lands". Palms often provide important NTFPS in natural rain forests, with economically important palm species often highly abundant and productive.

We analysed over 200 scientific publications and internet resources in order to obtain a comprehensive picture of the extent, structure and potential of trade in palm products in northwestern South America. The study is part of the project "Palm Harvest Impacts in Tropical Forests", funded by FP7. We found trade taking place mostly at local and regional levels. Trade volumes of some palm products regionally traded (palm thatch, aguaje fruit) are very high, and larger than that of any exported native palm product. A wide range of different palm products are locally or regionally the most important sources of cash income for families and/or communities. Trade volumes inadequately reflects their socio-economic importance.

Palms can provide very high per-hectar yields both in natural and managed stands. However, most palm products are still obtained by destructive harvest. There is a massive and on-going qualitative and quantitative erosion of palm stands.

Palm products for the local, regional and national markets from natural, managed or cultivated palm stands with sustainable management could be drivers of the regional economies in low-land regions with poor, shallow and swampy ground. Poor management, poor governance, insecurity of land tenure and unequal sharing of profits currently inhibit the development of sustainable and economically viable markets for palm products.

Keywords: Palm products, rain forest, sustainability

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May Tropical Regions Suffer from a Climate-change Induced Decline of Plant Species Richness?

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Biodiversity represents a major precondition for human wellbeing also in managed landscapes and for agricultural production in the tropics. Biodiversity facilitates provisioning, regulating and supporting ecosystem services at genetic-, species- and ecosystem level. Even though climate change represents a major challenge to the maintenance of global biodiversity and to human development, little is known about the magnitude of related imminent changes in the global distribution of plant diversity. We present results of an empirical multi-variate analysis of the global relationship between climatic and environmental variables and the regional capacity for plant species richness as a proxy for overall biodiversity, and its projected future changes according to climate projections and possible impacts of land use change. We find a strong relationship between the magnitude of projected temperature rise and the modeled response of the capacity for plant species richness. In global average, for the optimistic B1/+1.8°C scenario until 2100, increases in some areas are compensated by decreases in other regions. This is in contrast to the more realistic 'business as usual' scenario (A1FI/+4.0°C), where the regional capacity for species richness may decrease by 9.4 % until 2100 in global average. In all cases, a geographically highly non-uniform pattern of the direction and magnitude of changes is evident across all considered models and scenarios. In most temperate and arctic regions, future conditions may provide habitat for more plant species than today, while there is an indication for a strong decline of the capacity for plant species richness in most tropical and subtropical regions, where in many cases 30–50 % of plant species may lose their suitable habitats. Hence, those countries that are least responsible for past and present greenhouse gas emissions are likely to suffer most from its negative consequences in terms of potential biodiversity losses. Given the comparatively high dependence of many agricultural production systems on climatic and other environmental conditions in tropical regions, comprehensive land management strategies also need to consider the status and dynamics of the biodiversity matrix in which they are embedded.

Keywords: Biodiversity, capacity for plant speices richness, climate change, global scale, land management, multi-variate statistics, tropics

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Conserving Biodiversity through the "Polluter Pays Principal": An Application to Agriculture Driven Land Use

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The environmental externalities framework in economics posits that markets may fail because they do not adequately price impacts to society and the environment, such as the loss of biodiversity and ecosystem services driven by land and water use in agriculture. Global patterns of agricultural production, consumption, and biodiversity are skewed. Richer, northern countries – of low relative biodiversity value – predominantly consume, while poorer, southern nations – of high relative biodiversity value – predominantly produce. Because the majority of biodiversity impacts occur during the production phase, the external costs of biodiversity loss due to agriculture are levied upon nations and peoples with the lowest relative capacity to afford them. Various policy mechanisms have been proposed to deal with external costs, and each reveals a set of assumptions that must be critically assessed. These include top-down approaches, such as protected area expansion and environmental taxes, or incentive-based approaches such as "habitat offsets" and payments for ecosystem services. This study investigates the potential of applying a "safe minimum standard" (SMS) to biodiversity, and shifting the costs of meeting this SMS to the consumer via the polluter-pays principal. This entails levying the cost of conserving a minimum set of protected areas on the economic activities that drive biodiversity loss. In doing so, developing nations may achieve an ecologically benign economic development while avoiding the significant external costs of biodiversity loss. Northern nations could express their willingness to pay for global biodiversity conservation in terms of higher prices on major commodities, thus providing a further incentive to reduce overall resource consumption – a prerequisite for environmental sustainability. I illustrate how such a system could be operationalized at both global and regional scales using early research results derived from a combination of techniques in spatial ecological modelling with data on agricultural production and other economic activities. I finish by discussing future developments and the overall potential of the proposed scheme, focusing on methodological issues of data availability and uncertainty.

Keywords: Agriculture, biodiversity, biodiversity loss, conservation, land use, polluter pays principal

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Does the Convention on Biological Diversity Protect Marginalised and Local People?

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In1993, the Convention on Biological Diversity (CBD) entered into force with three objectives, (1) conservation of nature, (2) sustainable use of bioresources, and (3) the fair and equitable sharing of the benefits arising from (2), so-called "Access and Benefit Sharing" or ABS. The origins of CBD lie in the conservation community who wanted an international framework to conserve nature; ABS and sovereign rights of states over its biodiversity were introduced to motivate countries to protect biodiversity. Since bioprospecting for pharmaceuticals was seen as a pioneering industry, promising to generate enormous amounts of profits, local communities, as holder/providers of traditional pharmaceutical knowledge were included into CBD. They are regarded as custodians of biodiversity and depend directly on ecosystem services.

In 2010, CBD has agreed upon the Nagoya Protocol to provide guidance and regulation to regulate access and organise the sharing of benefits.

Thus, CBD transformed into a Convention on Development, on how to transfer wealth from North to South and a Convention on Trade, on how to exchange genetic resources. These issues interfere with existing conventions, institutions and practices, such as WTO, TRIPS, MDGs and FAO but possibly also exchange of bioresources amongst communities.

Hence CBD has major impacts in a wide range of development issues. Current perception is that ABS discussions, even without national legislation in place, rather hinders than promotes activities, which could help marginalised people. Modest benefits are indeed arising but do not seem to promote conservation. Hopes in 1980ies for pharmaceutical based "Green Gold Rush" are largely disappointed, and the term is used today for biofuels instead.

In agriculture potential benefits are small and benefits arise with significant time delay (for pharmaceutical 5–10 yrs), however, needs for livelihoods and conservation are here today. In general, the benefits arising from breeding are comparatively small and varieties consist of many small contributions by breeders all over the world. This make the actual sharing of benefits in a bi-lateral system as envisaged by ABS impossible.

Keywords: Access and Benefit Sharing, biofuels, biopiracy, convention on biological diversity, IP, local people, marginal people, traditional knowledge

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Habitat Suitability Modelling for Tiger (*Panthera tigris*) in the Hukaung Valley Tiger Reserve, Northern Myanmar

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Tiger (*Panthera tigris*) requires large areas of contiguous habitat for long-term survival. In the world's largest tiger reserve, the Hukaung Valley in northern Myanmar, the tiger population is declining due to a combination of habitat loss, human interferences and decreasing prey availability. Identification of high habitat quality areas for tiger is urgently needed for future conservation of that species in the study area. Remote sensing (RS) and geometric information systems (GIS) can be used as tools to assess environmental variables relevant for habitat selection of wildlife species and they can help to monitor larger areas of habitat. We modelled habitat suitability using the empirical multivariate approach of the Ecological-Niche Factor Analysis (ENFA). The principle of ENFA is to compute suitability function by comparing environmental variable values of species presence cells with respective mean values of the entire study area. Independent data for the model came in form of ecogeographical variables (EGVs) on land use, topography and human-factors features whereas tiger presence points formed the response variable. Landsat imagery and land cover classes from existing map were used for producing a segmentation-based land use map. The classification key of the map was constructed based on literature review and expert interviews, including feature classes which were assumed to be relevant for tiger ecology. Preliminary modelling results (suitability map) showed that areas of high habitat quality are associated with large areas of evergreen opened forest and kaing grass in the study area. The applied model appears to be a very promising method to build habitat suitability models also for other endangered species.

Keywords: Ecogeographical variables (EGVs), Ecological-Niche Factor Analysis, habitat suitability model, Hukaung Valley Tiger Reserve, multivariate empirical modelling, remote sensing (RS), geometric information system (GIS), tiger

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Vegetation Types in the Dieng Mountains and their Effects on Bird and Mammalian Species Richnesses

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For centuries, human activities in Java's uplands have been known to cause deforestation and severe habitat degradation, thus diminishing the role of montane forests in sustaining the ecosystem function, including their role as wildlife habitats. The change in landscape as a result of human activities, particularly farming-related ones, in the Wonosobo District part of the Dieng Mountains was observed by analysing the vegetation structure and floristic composition of three types of vegetation found in the area: woodland, shrubland, and grassland. The numbers of bird and mammal species were measured and used to value each vegetation type as a habitat for wildlife. Vegetation data were collected using concentric circular plots of various sizes. Data on the mammalian community were collected using indirect methods employing strip transects on the three habitat types and structured interviews. Bird community surveys were conducted using point transect distance sampling on the same habitat types, as well as on agricultural land. Woodland showed a relatively low density of trees with a poorer regeneration compared to that of shrubland, while shrubland displayed a typical transitional structure with a high density of saplings and regenerating trees. The species richnesses of trees and saplings were low in all vegetation types, but the species richnesses of shrubs and herbs were high. Bird species richness decreased from woodland and shrubland to agricultural land and grassland. Woodland, shrubland, and grassland had similar number of mammal species. The results suggest that 30 years after the reforestation effort, the woodland structure has not shown a sign of recovery to a state comparable to its original condition. The current condition of the shrubland and grassland may indicate that recovery still has a long way to go. This condition may not be favourable for wildlife populations. Considering the importance of the Dieng Mountains ecosystem, further land conversion should be prohibited and effective measures to improve the ecosystem should be carried out immediately.

Keywords: Bird, Dieng Mountains, land use, mammal, montane forest

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Bushmeat Hunting and Sustainability of Blue Duiker Off-takes in the Northeastern Periphery of Korup National Park, South-West Cameroon

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In Afrotropical rainforests, bushmeat off-takes exceed the sustainable harvest rates even if hunting is practised with rudimentary methods. The aim of the present study, carried out from May to September 2010 (during the rainy season) at the northeastern border of Korup National Park (KNP) in southwestern Cameroon, was to analyse patterns of bushmeat hunting and to evaluate the sustainability of blue duiker off-takes. A total of 65, out of the 187 hunters and trappers found in the study area, were monitored, in the forest and in villages, in order to map village hunting territories, to evaluate the hunting effort and to estimate the harvested biomass. Age structure of the blue duiker was determined by analysing the tooth eruption and wear in the lower jaw particularly for the molars. A questionnaire was administered to 47 out of the 65 hunters and trappers monitored. We found that trapping was performed by 80 % of hunters. The average number of traps per trapper was 108. Snare-traps density was 156 traps km^{-2}. Traps, that functioned continually days and nights, were checked on average every 3.1 days. The duration of a gun-hunting expedition, including resting time, was 5.5 days. The average harvested biomasses were 0.92 kg per gun-hunter per day and 0.7 kg per trapper per day. About 55 % of the total off-takes were sold, given a daily average income per hunter of 1179 CFA francs (*i.e.* 1.80 Euros). Blue duikers, the 3rd most hunted species in number, constitute up to 23 % of the total harvested biomass. When applying the Feer's (1996) logistic model, off-takes of blue duikers were 6 to 21.2 times higher than the maximum and minimum sustainable productions for the study area. However, sex and age class structures suggested that the blue duiker population could be recovering from the current level of off-takes. Therefore, to draw a definitive conclusion, it is necessary to collect similar data in the dry season.

Keywords: Blue duiker, bushmeat off-takes, gun-hunting, harvest model, Korup area, sustainability, trapping

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Ecological Trade-offs between Plant Biodiversity, Land-use and Management Intensification in Agroforestry Systems of Bangladesh

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Agroforestry, because of its diverse options and structures is sometimes believed to be most suitable for conserving biodiversity, particularly in tropical landscapes where rural people depend heavily on nature for sustaining their livelihoods. However, since agroforestry systems are subjected to some level of cultural management it is also critical to understand how cultural management and different levels of intensification affect biodiversity in agroforestry landscapes. We conducted an exploratory survey on four contrasting agroforestry systems; *viz*., betel-vine (*Piper betle*) based agroforestry, lemon (*Citrus limon*) based agroforestry, pineapple (*Ananas comosus*) based agroforestry, and short-rotation shifting cultivation in a tropical forest patch of Bangladesh, to assess the response of plant community to different levels of management intensification.

A unique management intensification gradient was developed identifying a total of 11 local cultural practices spread across the studied agroforestry systems. We recorded 173 plant species (61 trees, 42 shrubs, 47 herbs, 18 climbers and 5 orchids) from forty 100 m^2 plots established in the four agroforestry systems. The Shannon-Weiner biodiversity index calculated was higher for betel-vine agroforestry (3.3), followed by 2.9 for lemon/horticulture agroforestry, 2.2 for pineapple agroforestry and 1.9 in short-rotation shifting cultivation system (comparable to 2.7 for forest). Species evenness index for tree was also higher in betel-vine agroforestry system (0.79). A simple linear regression was performed for each of the studied agroforestry systems to realise the response of different plant functional groups to a weighted management intensification value. It was observed that plant biodiversity is highly sensitive to management intensification, and the response of different plant functional groups to different management regimes varies greatly on the type of agroforestry systems and the kind of expected products. The study also suggested that some practice (for example here betel-vine agroforestry system) that evolved through indigenous innovation is suitable for conservation of plant biodiversity and could offer a basis for sustainable forest management.

Keywords: Agroforestry, Bangladesh, land-use, Lawachara National Park, management intensification

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Classification of Local Mango Varieties in Kenya by Using a Morphological Characterisation and Identification Approach

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Mango (*Mangifera indica*) is a highly valued fruit in Kenya, but its potential is not yet fully exploited. The available data and literature focuses on the economically important introduced, commercial varieties. Nevertheless about 30 % of mangos grown in Kenya are local varieties, which are greatly treasured for home consumption and are regarded as relatively drought tolerant and less susceptible to pests and diseases. These characteristics would make them interesting as rootstocks and for breeding purposes, but no data to support the statements and to lead further research activities are available. The diversity of local languages and names for mangos in Kenya leads to difficulties in clear identification of mango varieties. No documentation about the number of local varieties exists. A descriptor list for mango was developed by Bioversity International (former IPGRI) to standardise morphological characterisation, but as many as 95 plant characteristics need to be determined. The objective of the present study was to develop a method for easy variety characterisation under field conditions by testing the effectiveness of bioversity's descriptors and selecting the most discriminant ones. In central and eastern Kenya, 37 local mango varieties were collected from 90 farms for characterisation using 67 selected qualitative (41) and quantitative (26) descriptors for leaf and fruit traits. Factor analysis was performed in a first step to identify highly auto-correlated morphological descriptors. Second, hierarchical cluster analysis was performed using Wards method after z-score standardisation of the quantitative and qualitative variables. Third, discriminant analysis followed by ANOVA and post-hoc analysis as well as chi^2-tests were used to identify those variables mainly responsible for the cluster formation. Seven qualitative descriptors (fruit shape, shape of fruit apex, depth of fruit stalk, fruit neck prominence, slope of fruit ventral shoulder, fruit sinus type and quantity of fibre on stone) and three quantitative descriptors (fruit length to width ratio, skin weight and seed length) were identified as highly discriminating variables. We recommend using these key descriptors to perform easy and time-efficient variety characterisation under field conditions. Classification of varieties by the selected morphological characteristics is planned to be compared with results of molecular marker analysis.

Keywords: Cluster analysis, intra-specific diversity, morphological descriptor, variety characterisation

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Managing Kaziranga as a Tiger Reserve: A Landscape Perspective

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Kaziranga National Park, Assam in the Brahmaputra floodplains has been managed for the endangered Greater One Horned Indian Rhinoceros (*Rhinoceros unicornis*) since its establishment. Recently the park along with adjacent managed forests and other lands has been declared as a Tiger Reserve as newly demarcated landscape harbors a considerable population of tiger. This study attempts to assess the relevance, adequacy and appropriateness of the landscape management approach adopted for conservation of tiger in the region. The methodology included reconnaissance of the area, review of literature, visit to representative sites and field verification, and interaction with forest/park officials. Study reviewed landscape boundaries, adequacy and management of core, buffer and other areas including corridors, habitat conditions, distribution and abundance of Tiger, its prey and co-predators. An understanding on the dependence of local people on the natural resources within the landscape was also developed Kaziranga National Park (KNP) within the larger Kaziranga Tiger Reserve (KTR) has potential to serve as core area or as a 'source' population and the spillover populations of different wild animals including tiger can disperse in the neighbouring forests/grasslands and agriculture/tea estates dominated matrix. Although at present the management authorities are paying adequate attention to the protection of tiger within the Kaziranga NP but the sink populations require greater attention and protection as the park interface is experiencing all round rapid development. Study concludes that the complex and dynamic landscape of this Tiger Reserve needs a holistic approach and integrated planning for long term conservation and viability of tiger in the region. Several other recommendations for the protection and management of tiger and also improvement of its habitat at the landscape level are being discussed in the paper.

Keywords: Kaziranga National Park, landscape management, population, tiger, tiger habitat

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Adverse Effects of Agrochemicals on Migratory Waterbirds in Africa

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Available information shows that the number of migratory birds is declining, but so far reasons are unknown. It is hypothesised that agrochemicals have adverse impacts on migratory waterbirds. In particular, fertiliser pollution can cause the destruction of their habitats and pesticide pollution can deprive them from their food or intoxicate them, consequently leading to metabolic disturbances, breeding failures, or instant death. Object of research was to find out, if the decline of migratory waterbirds might be a result of their residence in Africa.

The information of the entire study was derived entirely from publications and grey literature. The data available at the time this thesis was written must be considered insufficient to deliver scientific evidence because of lack of recent data. Hence, all findings are preliminary. Conclusions made cannot be interpreted as proof but could be used as indicators for further empirical research.

Focus was put on the species covered by the African Eurasian Waterbird Agreement (UNEP-AEWA). Information about breeding time, feeding habits, habitats and time of residence in Africa was derived from literature. It was then correlated with information about population size, population trends, distribution, and migratory behaviour derived from UNEP-AEWA.

Data about the application of pesticides in Africa is scarce or if available out-dated or inconsistent. Pesticide legislation, particularly in sub-saharan Africa, is weak. Their prices have increased since the implementation of structural adjustment programmes in the 1990s. African farmers rely on pesticides and the majority of poor farmers acquire pesticides of doubtful quality from illicit sources and lack knowledge about the correct handling of pesticides as described in the used literature.

Environmental destruction and pesticide pollution have occurred in the past and are still occurring today on an increasing scale. Information about population declines, breeding time, feeding habits, habitats of the birds covered by UNEP-AEWA combined with the information of the unregulated pesticide markets, allow the assumption that pesticide application, mostly overdosed, is contributing to the declining numbers of migratory waterbirds.

Keywords: Africa, agrochemicals, fertilisers, pesticides, waterbirds

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Natural Dry Forests: Towards Combating Desert Like Formation in the Central Dry Zone Area, Myanmar

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Dry forests in Myanmar play an important role for the local communities by providing basic needs as well as assuring the stability of microclimate, land productivity and combating desert like formation in the dry zone area of Myanmar. The study was conducted with the main objective of specifying current situation of natural dry forest in terms of tree species composition, horizontal and vertical stand structure and natural regeneration. The measurements (diameter at breast height, total height, and species) were done in the three different site conditions (*i.e.*, primary forest, secondary forest, and degraded forest) of the same forest type located in the central dry zone area of Myanmar. The data from a 0.4 ha cluster sample plot were analysed using species-area curves approach, important value index (IVI), diversity indices, Weibull 2- and 3- parameters function for diameter distribution and IUFRO classification scheme for height distribution. Species-area curves revealed the sampling area was enough for vegetation analysis. The two most dominant species (*Terminalia oliveri* and *Tectona hamiltoniana*) were denoted by the important value index and they have a regular horizontal distribution. The diversity indices indicated that the species diversity and heterogeneity were mainly depended on nearness to the adjacent forest stands. The natural regeneration of the two most dominant species as well as some associated species was sufficient for the sustainability of dry forests in the long term. Natural dry forests are going under a sustainable way and they play an important role in combating desert like formation in the central dry zone area of Myanmar.

Keywords: Dry forests, important value index, species diversity, species-area curves, stand structure

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High Hymenopteran Species Richness in Small Scale Farming Systems of Coastal Belize

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An important today's challenge is to meet the increasing demands for resources and at the same time the need of biodiversity and ecosystem protection. Research in agroecology aims to identify systems where food and goods can be produced while conserving biodiversity. In northern coastal Belize, Central America, we compared hymenopteran communities between small scale farming areas and natural forests along a humidity gradient. Specifically, we investigated three functional groups of Hymenoptera: wild bees (Apiformes) as important pollinators of wild and crop plants, paper wasps (Vespidae) which predate on insects and may play a role in pest control, and spider wasps (Pompilidae) that provide their brood cells with anesthetized spiders (an intermediate form between predation and parasitism). In 2010 wasps and bees were collected with Malaise-traps in the protected forest area of Shipstern Nature Reserve (seven sites) and in adjacent small scale farming areas (eight sites). Traps operated for three months during the transition from wet to dry season. Farming areas consisted of a mosaic of open habitat, secondary forest, and agroforestry. First results are available for paper wasps; the results of the remaining groups are under way. Paper wasps showed higher abundance and species richness (almost doubled) in the farming areas compared to protected forest. The higher species richness in farming areas was due to supplementary species that did not occur in the forest, however all forest species were found in farming areas, too. The communities in the farming areas were highly dominated by one single species whereas the communities in protected forest were more evenly distributed. These first results indicate that small scale farming adjacent to protected areas may not only conserve but even favour biodiversity of some taxonomic groups. This pattern could be driven by the higher habitat heterogeneity and therefore better resource availability in small scale farming systems compared to closed forests.

Keywords: Agroforestry, Belize, biodiversity, community evenness, habitat heterogeneity, Hymenoptera, Malaise trap, species dominance, subtropical forest ecosystem, sustainable land use, wasps and bees

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Study of Knowledge on Medicinal Plants in Zetaquira and Campo Hermoso Municipalities, Boyacá-Colombia

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Conservation of knowledge on medicinal plants has been observed to some extent in few communities in rural areas. Nevertheless, the traditional knowledge that has been identified is already eroded, if not in all, then in most of the studied localities. Contributions to conservation of traditional knowledge is still remain. An ethnobotanical study was carried out in the municipalities of Zetaquira and Campo Hermoso, Departamento de Boyacá, Colombia. The study focused on identifying local factors that promote the knowledge on introduced and native medicinal plant species in both municipalities, and to describe medicinal uses of plant species in the two localities.
Within the methods: A survey and qualitative methods for data collection were applied. Subsequent calculations of IUV values, and Jaccard index were completed. Statistical tools -Kruskal-Wallis test and a GLM regression- were used through the analysis. Forty-one adults, who represented diverse groups from the communities were interviewed. Twenty-five interviewees came from Zetaquira and sixteen from Campo Hermoso. Additionally, a questionnaire survey was conducted with students of local schools. Data of 195 students from Zetaquira and 177 students from Campo Hermoso could be used for further analysis.
Adults' knowledge on introduced and native medicinal plants was related to their strata of the subsidised health service system (SISBEN) and to their occupation. Regarding students' knowledge, their place of residence and level of class were the most influential factors.
Students described 51 medicinal plant species, while adults described 80. In total, seventy-eight species with medicinal use were identified of which 35 were native and 43 were introduced. The species belonged to forty-one floristic families. The most popular families were Asteraceae, Lamiaceae, Apiaceae, Rutaceae and Verbenaceae.
In Zetaquira, introduced plant species were significantly more popular than native ones (IUV), whereas both groups were equally popular in Campo Hermoso. The most popular plant parts for medicinal use were leaves which in most cases were prepared by decoction or infusion.
In general, students and adults knew more on introduced plant species than on native ones. The distribution of knowledge could be influenced by a number of social and ecological factors that are discussed in this contribution.

Keywords: Boyacá-Colombia, ethnobotany, traditional knowledge

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Domestication of *Chrysophyllum albidum* from Rainforest and Derived Savannah Ecosystems – Phenotype Variation and Selection of Elite Trees

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Many forest food tree species have immense socio-economic, nutritional and cultural importance. They contribute to food security and increase the diversity of foods necessary to reduce monotony in diets of rural people. Their importance notwithstanding, their regeneration has been neglected. Due to lack of care and old age, fruit yield of existing trees is decreasing, which if not addressed will endanger rural the livelihood. This study investigates phenotypic variation of *Chrysophyllum albidum* in rainforest and derived savannah ecosystems of Nigeria with the aim of selecting elite trees for multiplication as cultivars. From each ecosystem, five villages with high abundance of *C. albidum* trees were selected. One hundred trees (10 from each village) were selected, numbered and tagged. The age and silvicultural history (whether planted or naturally regenerated) of each tree were obtained. Measurements of tree growth parameters and phenotypic variations were made in 2010. Palatability test based on sweetness, fibrousity, juiciness and smoothness was conducted by three test persons. Results indicated greater domestication activity by farmers in derived savannah than rainforest ecosystem. While 6 % (3/50) of the trees in rainforest were planted, 36 % (18/50) were planted in derived savannah. There was an element of positive selection in domestication by farmers as fruits of domesticated trees were generally bigger, sweeter and non-fibrous. Trees in derived savannah were younger and smaller (age: 20–50 years; dbh: 4.0–72.6 cm; height: 5.1–28.6 m) than those in rainforest ecosystem (age: 50–55 years; dbh: 16.5–125.3 cm; height: 10.8–28.8 m) due probably to higher domestication activity, since domesticated trees were generally younger. A high percentage of trees were found within agroforestry plots. Fruit variations were as follows: length: 2.26–4.76 cm; width: 2.0–74.10 cm; fruit weight: 28.23–86.06 g and pulp weight 8.55–46.14 g. The criteria for selection of elite trees were big fruits, very sweet, juicy and non-fibrous fruit pulp. Since most trees did not met all the criteria, fruits from the few trees (seven) that met the criteria were collected between in 2011 for nursery experiment as an important step towards their domestication. Thus, we have selected elite trees from this first screening and collected fruits for further research and experimentation.

Keywords: *Chrysophyllum albidum*, domestication, elite trees, forest food trees

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Floristic Composition of Riparian Vegetation of a Stream in the Northeast of Pará State-Brazil

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Riparian forests are essential in the preserving water quality, maintaining stream integrity, providing wildlife habitat and the soil around it. However, these forests are being threatened due to development with no or little planning and action is needed to recover the natural vegetation. As one example, these threats are evident in the northeastern region of Pará State (Brazil) and here, urgent intervention is required to control or reverse the damage. Given that it is necessary to know the plant species expected in typical riparian vegetation in such areas, we undertook a floristic study of an undisturbed area as a basis for comparison and recovery of vegetation of disturbed areas. Our study was on the floristic composition of riparian vegetation of the Golpe stream which located near the city of Aurora do Pará in Pará State. Over 490 m of the stream were demarcated on the left and right banks using 16 plots of 20×100 m with intervals of 10 m. From these, five plots were selected in each bank to collect data. Details of height, DBH and description of the stem were collected for shrubs and trees with DBH > 5 cm. Botanical samples were collected and subsequently identified. Fertile specimens were deposited at the IAN Herbarium. In the study area, we gathered 2,426 specimens in 56 families, 153 genera and 275 species. The most representative families by number of specimens were Leguminosae (554), Lecythidaceae (284), Burseraceae (205), Sapotaceae (180), Annonaceae (128), Malvaceae (120), Chrysobalanaceae (116) and Euphorbiaceae (105). The families with the highest diversity of taxa were Leguminosae (50 species), Sapotaceae (24), Lauraceae (19), Chrysobalanaceae (14) and Burseraceae (10), followed by Annonaceae, Euphorbiaceae and Myrtaceae with 9 species each. The estimated forest basal area was approximately 27.80 m^2 ha^{-1} and the density was 1,215 ind. ha^{-1}. Around 20% of the community are composed of two species(*Macrolobium bifolium* (Aubl.) Pers and *Eschweilera coriacea* (DC.) S.A. Mori) and 60 % of the species have up to two trees ha^{-1}.

Keywords: Amazonian, conservation, inventory

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DNA Barcoding Discriminates Freshwater Fishes from Southeastern Nigeria and Provides River System Level Phylogeographic Resolution within some Species

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Fishes are the main animal protein source for human beings and play a vital role in aquatic ecosystems and food webs. For sustainable exploitation of fishery resources, a comprehensive understanding of the ichthyofaunal composition of the water bodies is crucial. However, unambiguous identification of fish species is problematic for fisheries development in Africa, since taxonomic expertise and comprehensive taxonomic keys are often lacking Fish identification can be challenging, due to high diversity, and this is particularly true for larval forms or fragmentary remains. DNA barcoding, which uses the 5' region of the mitochondrial cytochrome c oxidase subunit I (cox1) as a target gene, is an efficient method for standardised species-level identification for biodiversity assessment and conservation, pending the establishment of reference sequence libraries.

In this study, fishes were collected from three rivers in southeastern Nigeria, identified morphologically, and imaged digitally. DNA was extracted, PCR-amplified, and the standard barcode region was bidirectionally sequenced for 363 individuals belonging to 70 species in 38 genera. All specimen provenance data and associated sequence information were recorded in the barcode of life data systems (BOLD; www.barcodinglife.org). Analytical tools on BOLD were used to assess the performance of barcoding to identify species.

Using neighbour-joining distance comparison, the average genetic distance was 60-fold higher between species than within species, as pairwise genetic distance estimates averaged 10.29 % among congeners and only 0.17 % among conspecifics. Despite low levels of divergence within species, we observed river system-specific haplotype partitioning within eight species (11.4 % of all species). Our preliminary results suggest that DNA barcoding is very effective for species identification of Nigerian freshwater fishes.

Keywords: Cytochrome c oxidase subunit 1, DNA barcoding, freshwater fishes, mtDNA, Nigeria, phylogeographic structure

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The Baobab Tree in Malawi: Abundance or Scarcity?

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Baobab (*Adansonia digitata* L., Malvaceae Family) fruit pulp has recently begun to be commercialised in Europe and the USA, offering a great opportunity for rural farmers in Africa. However, for many plant products, the opening of new market niches increases the demand which in turn often increases the difficulty of managing plant populations sustainably. The baobab tree provides nutritious food, medicine, fibre, fodder and crafts (apart from income) to local people in Africa. Despite the number of recent studies on this species, little is known from Malawi, the main exporter of baobab fruit pulp in Africa.

Information on distribution and density was gathered from field surveys. Maxent was used together with spatial environmental data and geo-referenced records of the baobab tree to analyse its ecological preferences and potential cultivation sites. Fruit and leaf morphological diversity was assessed in eight study sites selected following a latitudinal gradient.

The baobab tree was found to be widely distributed in southern Malawi, with variable densities. Modelling results show that this species could be cultivated in most of the southern region. A large morphological diversity in both fruit and leaf characteristics was observed, which gives the opportunity to select more desirable characters. While some high density areas could be further exploited ('local abundance'), as there is little natural regeneration ('future scarcity'), cultivation is recommended, especially in areas having low baobab density in southern Malawi. Although further studies considering genetic variation are necessary, it seems that there is room for selecting superior baobab tree planting material.

Keywords: *Adansonia digitata*, cultivation, density, distribution, morphology

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Native Chili Peppers Conservation using Agroforestry Multistrata Systems in Peruvian Amazon

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Amazon rainforest is one of the most diverse ecosystems which form a habitat for more than 50 % of described plant species. According to many factors of interruption and destruction of this ecosystem many native species with high pharmaceutical and nutritional importance are lost every year. Among this species are also Amazonian chili peppers. Our investigation was focused on conservation of less known native chili peppers in agroforestry systems. In the Ucayali region we determined 21 native chili pepper species by phenotypic description. To see local importance of chili peppers Market study via structured questionnaires was done in biggest local markets and restaurants. Analyzing more than 65 questionnaires result in preference of only four native chili pepper species, of which 2 have massive consumption. This preference affects also local ecological producers who try to cover market requirements. Quality fruit samples of 21 determined species were prepared to detailed pharmaceutical analysis of capsaicin, antioxidant and Ascorbic acid content. Majority of analysed species presents high importance on international market and pharmaceutical development. To conserve the species and quality of the fruits is important conserve also environmental conditions. In tropical regions Multistrata agroforestry plantation is the best productive system for native chili pepper production. We hope, this investigation helps to conservation of native chili peppers species and to the development on pharmaceutical level.

Keywords: Market analysis, multistrata agroforestry systems, native chili peppers, plant species conservation

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Preliminary Information on the Density and Distribution of Duikers in the Oban Sector of Cross River National Park, Nigeria

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Duikers (Cephalophinae) represent a very high percentage of animal species killed for meat across forested West and Central Africa, and their populations are likely becoming depleted even in protected areas. There is therefore a strong need to provide baseline data for wildlife conservation, monitoring and management. So far, however, there is but very few reliable biological and ecological data on duikers, especially in Nigeria. We assessed the current status of duiker populations in the Oban Sector of Cross River National Park, using the line-transect method. Diurnal and nocturnal surveys were conducted along 32 transects of 2 km length each in four land use types *viz*: core of the park (closed canopy forest), buffer zone (secondary forest), farm fallow and plantation. Eight transects were located in each of the land-use types in four locations evenly distributed over the Oban Division of the Park. After 508 km survey effort on these transects, only two out of four species of duikers of the region were recorded, namely: Ogilby's (*Cephalophus ogilby*) and blue duiker (*Cephalophus monticola*). The two larger duiker species known from the region (yellow-backed *C. sylvicultor* and bay *C. dorsalis* duiker) were not observed at all. Using habitat as a covariate in modelling detection probability in DISTANCE 6.0, we calculated densities of each species and for each habitat. For the blue duiker, estimated densities ranged from 15.5 (95 % Confidence Interval C.I.: 7.8 – 30.9) in the core, over 5.8 (C.I.: 2.6–12.9) in buffer and 0.9 (C.I.: 0.09–10.1) individuals per km^2 in fallow to no duikers in the plantation. For the Ogilby's duiker, estimated densities ranged from 1.6 (95 % C.I.: 0.7–3.7) individuals per km^2 in core, over 1.6 (0.8 – 5.1) in buffer to no duikers in farm fallow and plantation. Based on these estimates, population sizes were estimated at a minimum of 16,000 individuals (lower bound of the 95 % Confidence Interval) for the blue duiker and 1,600 individuals (lower bound of the 95 % Confidence Interval) for the Ogilby's duiker in the 2,866 km^2 study area, with most occuring in the 2,064 km^2 core area of the Park (lower bound of C.I: 16,100 blue and 1,400 Ogilby's duikers). These data may serve as a basis to call for increased conservation efforts in order to restore depleted duiker populations and as a baseline for a model on hunting management. The apparent absence of yellow-backed and bay duikers may be an indication that these two species have already become locally extinct as a result of hunting and land use. There is therefore an urgent need to improve on the management of the Park.

Keywords: Abundance, Cross River National Park, density, duikers, encounter rate

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Reconciling Conservation and Local Sustainable Development: Case Studies from Los Tuxtlas Biosphere Reserve, Veracruz, Mexico

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The Los Tuxtlas Biosphere Reserve located in the eastern Mexican State of Veracruz is a geologically and ecologically diverse area, associated with steep altitudinal gradients (from sea-level to 1.720 m a.s.l), the presence of ca. 300 inactive volcanoes and maritime influences from the Golf of Mexico. It is one of the five areas in Mexico with highest rates of endemism.

Despite being located between two important poles of economical activity, the harbour of Veracruz to the north and the conurbation of Coatzacoalcos-Minatitlán, the centre of the Mexican oil industry to the south, it remains an economically marginal region, which has undergone enormous socio-ecological changes in the last 60 years. Among other important drivers has been the decision of the state to redistribute land to local indigenous as well as immigrated landless peasants to found agricultural communities in the spirit of the agrarian reform inspired by the Mexican Revolution. Together with the development of private cattle ranching, this has since led to the loss of ca.85 % of the original forest cover, but has failed to significantly raise the living standards of most of the local population.

Since the 1980s conservation efforts have led to the area being designated UNESCO Biosphere Reserve, a protected area concept, which in particular since the 1990s seeks to reconcile the multiple use of natural resources with conservation goals, while fostering the increasing participation of the local population in conservation management.

Three case studies based on qualitative empirical social research methods are presented. These illustrate: 1) the current local implementation of a national programme for the payment of ecosystem services towards climate mitigation; 2) existing efforts to foster ecotourism and how this may impact the perception of the biosphere reserve, and 3) the contribution of coffee plantations to the local economy. Based on the lessons learnt from these cases studies, we reflect upon existing efforts and challenges in fostering synergies between local sustainable development and conservation in an economically marginal area, characterised by high levels of out-migration and unemployment.

Keywords: Biosphere reserve, coffee cultivation, conservation, ecotourism, Los Tuxtlas Region, payment of ecosystem services, sustainable development

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Ecuadorian Chocó: Forest Development and Nature Conservation in a Marginal Eco-region

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As a part of the Tumbes-Chocó-Magdalena eco-region the Ecuadorian Chocó evergreen forests harbor a unique biological diversity. This zone is also famous for its cultural heterogeneity which comprises different Afro-Ecuadorian and indigenous tribes.

Yet the Ecuadorian Chocó has lost more than 95 % of its original forest cover. Transformation and degradation of these forests continue at unprecedented speed.

Key research questions for a bachelor research and thesis were: Which possibilities do exist to conserve the remaining forest ecosystems while meeting the needs of present and future generations in the Chocó? Which of the forest management systems currently applied in this region have proven to be the most beneficial and ecologically sound for local people?

The methodologies to answer those above questions include field excursions to primary and secondary forests, oil palm plantations, protected areas, farmlands, rural communities, literature reviews, interactions with local people, forest officers and rangers, as well as semi-structured interviews. The latter were conducted with subsistence farmers, company managers and representatives from non-governmental organisations.

Key findings were that most rural people live at least partially from subsistence agriculture while often lacking access to basic infrastructure. Many farmers regard the transformation of forests into cattle pasture and oil palm plantations as more lucrative than maintaining the forest cover. Uncontrolled logging and hunting are frequent problems in protected areas. Violent land disputes are common.

However, there are also initiatives for a more sustainable forest management, such as “Fincas Integrales” and multi-species tree plantations. These models promote an ecologically sound land use while creating income opportunities.

Different international institutions conduct studies on biodiversity, conservation and development.

The research concludes that the Ecuadorian Chocó is a marginalised eco-region which hosts significant potential for a development that benefits man and nature alike. Urgent measures should be adopted to prevent further environmental degradation. These include governmental aids for sustainable small-scale farming and agro-forestry, afforestation and reforestation, the application of reduced impact logging, stronger support for protected areas and a stop to the expansion of oil palm plantations.

Keywords: Biodiversity hotspot, deforestation, Ecuador, subsistence farming, sustainable forest management

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Implementation and Potentials of Certification Mechanisms on Biodiversity Conservation Projects in Kigoma Region and Coast Region, Tanzania

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The aim of this study is to explore the relationship between Payments for Ecosystem Services (PES) concepts and the implementation of biodiversity conservation projects in Tanzania with the focus on Kigoma Region and Coast Region. Biodiversity and the multifunctionality of ecosystems are closely connected, and there is a positive relationship between biodiversity and the resilience of ecosystems. The high dependence of rural local population on ecosystem services is a major challenge for implementing conservation and sustainable management practices of these ecosystems. Already existing approaches such as the Clean Development Mechanism (CDM) or REDD+ (Reducing Emissions from Deforestation and Degradation) foresee the compensation of the local population by international payment schemes. Certification of protected areas and trading these certificates is another approach to implement market based systems for nature and environmental protection services.

For Tanzania biological diversity has important economic and social implications especially in rural traditional agricultural societies. Kigoma Region and Coast Region are important biodiversity hotspots with enormous flora and fauna varieties in wetland ecosystems. In Kigoma region, the study will concentrate on large wetlands formally designated as the Malagarasi-Moyowozi Ramsar site, which is important for the watershed protection for Lake Tangayika. In the Coast Region, the study focuses on Saadani National Park, which is Tanzania‘s only National Park bordering the ocean sea.

Linking local communities to global certification mechanisms enhances awareness of biodiversity conservation and the potential of external financing. On the other hand further challenges occur since most of the global certification standards yet have to prove their practicability, particularly in rural African contexts. By presenting challenges and prospects of biodiversity conservation projects institutional pre-conditions for the implementation of global standards for biodiversity and other ecosystem services are detected. In addition synergy effects of CO_2 mitigation and biodiversity conservation projects are identified.

The study bases on empirical research conducted in Tanzania between June and September 2011 within the framework of the international research project “Certification of Protected Areas” (CERPA) at the Institute for Environmental Economics and World Trade at the University of Hanover.

Keywords: Biodiversity, certification, payments for ecosystem services, Tanzania

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People, Forests and Rural Development: Re-discovering the Neglected and Underutilised Ethnobotanical Heritage of Northern Thailand

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The uplands of northern Thailand are inhabited by numerous agricultural communities of high ethnological interest, whose indigenous knowledge and tribal culture are rapidly eroding. Increased population pressure, coupled by depletion of genetic, soil and water resources as well as climate change challenge the region's food and nutrition security. This has an apparent effect on the formerly rich forests and indigenous cultures of the area, which are actively degrading. This puts at stake the livelihood basis of many rural communities, which largely depend on wild, naturalized or non-cultivated plants that provide a means of social security, mainly in the form of food supplements, herbal medicines, fuel, low-cost building materials, agricultural implements, as well as sources of income. Several forest plants are linked to spiritual rituals and beliefs, while economically important species provide a buffer against unemployment during economic depressions. This is particularly important for women and landless people, which generate a significant income through collection and sale of wild plant resources.

Many of these species are nutritionally superior to most of the conventional agricultural crops and are adapted to local climatic conditions and low input agriculture. While such crops can potentially improve nutrition levels, incomes and environmental health, they remain inadequately characterised and neglected by research and conservation. At the same time, they are largely unknown to international markets which can potentially direct financial capital to the region's least developed areas, through the development of value chains for quality nature products.

This research documents the ethnobotanical knowledge of two communities of the Karen and Black Lahu tribes of northern Thailand, following an approach that involves local traditional plant experts, farmers, biologists and social scientists. Systematic collection of biocultural data, supported by voucher herbarium specimens, forms the basis for an extended inventory of more than 350 native wild plants. This is complemented by free lists and cultural domain analyses, land-use maps, seasonal calendars, matrix rankings and market surveys for the prioritisation of selected species according to their ecological, cultural and economic attributes. The results provide inputs for innovations in the field of agricultural diversification through optimal utilisation of local genetic resources.

Keywords: Biodiversity-based productivity, ethnobotany, genetic resources, livelihoods, neglected & underutilised species, participatory research, sustainability, traditional knowledge

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The Political Landscape of Agricultural Conversion and Conservation Institutional Alliances in Kerala, India

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Development at the margins has at least two faces. On the one hand, new opportunities for livelihoods may result in integration in to mainstream economy and conversions of farming-systems. On the other hand does change critically endanger the conversation functions of remote and less frequented places. The question arises which development pathways for sensitive areas might lead to a sustainable future for all? This contribution wants to look into the political landsape of conversion and conservation in a highland district in southern India to analyse the driving factors and interest groups fostering the dramatic change of land use taking place. The focus rests on the relation between mainstream society and the indigenous tribal population, who both are affected by a rapid decline of paddy cultivation and a conversion into banana plantations.

The study rests on a empirical analysis of the institutional environment governing rice-cultivation with a special concern for agrobiodiversity. The data consists on interviews and net-map analysis with adminstration and civil society, tribal organisations and political institutions on community level. Sketching the linkages of the political landscape of rice conserving and rice conversing forces, the hidden interests of assumed unintentional change can be shown. Considering the political, the adminstrative and civil society allow to describe the powerfield in which the marginalised tribal population is operating. This analysis is a first step to identify possible allicances for a sustainable development at the margins. Agrobiodiversity may serve as an indicator to highlight the interrelation between society and its natural resources as well as between mainstream and tribal population.

Keywords: Agrobiodiversity, indigenous population, land use change, political economy

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Modelling Social-ecological Systems to Understand Ecosystem Service Trade-offs

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Ecosystem services (ES) trade-offs occur when the provision of the ES is reduced as a consequence of increased use of another ES. The growing demand to meet the human needs particularly for food causes the decline in other ecosystem services such as (agro)biodiversity which are both crucial to human wellbeing. In the recent years, payments or rewards for ecosystem services (PES) as a market based instrument has widely recognised as a management approach to address both the environment conservation and human welfare while serves as a policy instrument to deal with the ES trade-offs. However, there is no solid understanding how PES could affect the synergies and trade-offs among ES. The challenge of ES trade-offs assessment lies on the complexity of ecosystem dynamics in which human and natural processes are coupled. The general problem of all ecological analyses and all environmental decision process is the enormous complexity of the investigated ecosystems and landscape patterns. Coupled human-landscape system is characterised as non-linear (chaotic dynamics), with unpredictable behaviour and interactions that span multiple levels of biological organisations or spatiotemporal scales. Since complex system violates the assumptions of reductionist techniques, the need to work across all manner of human boundaries at different geographic scales (including downstream and upstream relations) is required. It involves an interdisciplinary work and cross-sectional approach of disciplinary boundaries (social and ecological sciences) to understand these complexities. To address this complexity, this research applies a multi-agent system modelling approach (MAS) to simulate and visualise the temporal and spatial scale effects on the trade-offs between goods and services. This research aims to develop a tool-based approach using MAS model to assess ES trade-offs and to support the design of PES schemes.

Keywords: Agent based modelling, ecosystem service trade-offs, social-ecological systems

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Interaction between Agrobiodiversity and Indigenous Knowledge in Marginal Drylands of Iran

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Agrobiodiversity or agricultural biodiversity is a relatively new topic that has only come within the last decade to the fore as an issue worthy of attention. It includes the diversity of animals, plants and microorganisms which are necessary to sustain function and structure of agroecosystems. The maintenance and use of agrobiodiversity relies on extensive indigenous knowledge, which address aspects such as cultivation practices and genetic resource management. Agrobiodiversity is affected by environmental and socio-cultural changes. Traditional farmers allover Iran rely on agrobiodiversity as an integral part of their production systems. In lower potential zones, they even actively manage biodiversity on farm. In Iran many poor, traditional communities are rich in biological diversity and have great knowledge of biodiversity conservation. These communities often possess a conservation ethic developed over centuries. Among the subsistence farmers, agrobidiversity represent the foundation of food security. In subsistence oriented production systems of Iran, farmers must grow a wide range of crops to meet nutritional and other needs. Some production systems, such as home gardens, intercropping and agropastoralism can achieve high level of biodiversity. Also many indigenous methods of agricultural management such as residual management, minimum tillage and manure application have important role in increasing biodiversity of soil microorganisms. The objective of this study was a better understanding of the interaction between agrobiodiversity and knowledge of Iranian traditional farmers (mainly West and Central Iran) in order to introduce these examples as successful locally-based natural resources management methods in other parts of Iran, with comparable environmental conditions.

Keywords: Biodiversity, local knowledge, marginal land

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Impact Evaluation of the ICRAF Tree Domestication Program in the Peruvian Amazon: A System and Participatory-based Approach

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Forests play a vital role in the global ecosystem by the provision of numberless benefits. The second largest share of Amazon rainforest, belongs to Peru. An exceptional total of endemic plants (20,000) make this region a strong candidate for conservation efforts.

The World Agroforestry Centre (ICRAF) by promoting systems of land use which involve trees as key ecological components intends to ameliorate, among others, deforestation. In 1995 ICRAF initiated the "Tree Domestication Program" (TDP) in the Peruvian region Ucayali to contribute to the slowdown of deforestation and to improve livelihoods. The aim was to indentify and later develop improved germplasm of promising native tree-species. ICRAF-professionals therefore requested the participation of small farmers to identify profitable species. Later on these species had been tested in research stations and in farmer´s fields, and eventually the most successful ones were distributed for their extended cultivation.

Impact evaluation targets the broad, longer-term impacts or results, whether intended or unintended of a program. In this impact evaluation, a theory-based approach, which means examining the assumptions underlying the causal chain from inputs to outcomes and impact, has been chosen. Given the complex interrelations in the TDP with its various actors, its overlapping scales, the different values and interests involved and the socio-ecological interactions, systems thinking, complexity and post normal science offered the theoretical framework needed for the impact-evaluation. Methodologically, participatory rural appraisal and Vester® sensitivity model were applied to operationalize data collection and analysis.

A number of indicators were identified to describe the TDP system. The results show those indicators which have a greater impact on the system than others. Because different actors have different perceptions of how the TDP-system works, the results vary from one group to another. The results have shown that professionals involved into the TDP tend to emphasise economic and organisational indicators as most important impacts. Small scale farmers however seem to consider social indicators as more crucial. However both groups agree on that the critical of the TDP is income.

Keywords: Agroforestry, amazon, impact evaluation, participation, system analysis, tree domestication

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The Economic Value of Environmental Services on Aboriginal Held Lands in Australia

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The need and opportunities for Aboriginal ranger groups and individual initiatives have recently been acknowledged to help with the management of northern Australia's vast land. Although very little research has been conducted on the community level, the potential of Aboriginal participation in PES-schemes on their traditional land raises great hopes as new conservation approach providing viable source of funding for the north. This study assesses the monetary value of benefits from three different environmental services that can potentially being provided by Aboriginal people on their land -biodiversity, carbon, recreational- by means of willingness-to-pay. The results showed that Australians could be willing to pay from $878 m to $2b per year for Aboriginal people to provide environmental services on their land. This is up to 50 times the amount currently invested by government. This result was derived from a survey that included a choice experiment with 927 respondents from all over Australia. The highest values were found for benefits that are likely to improve biodiversity outcomes, carbon emission reductions and improved recreational values. Of the activities that could be undertaken to provide the services, feral animal control attracted the highest level of support followed by coastal surveillance, weed control and fire management. Respondents' decisions to pay were not greatly influenced by the additional social benefits that could arise for Aboriginal people spending time on their traditional country while providing the services. Respondents showed, however, positive preference for reduced welfare payments that might arise for Aboriginal people when engaging in PES schemes as new source of income.

Keywords: Biodiversity conservation, choice experiment, non-market evaluation, payments for environmental services

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Forest Certification as Basic Requirement for Payments for Environmental Services

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Forest Stewardship Council (FSC) is the leading forest certification system with over 140 million hectares of forests certified in some 80 countries. FSC principles and criteria provide an internationally recognised standard for responsible forest management. Although FSC has made great progress since its creation in 1993, it remains largely focused on certifying "wood" products entering international timber markets. Therefore a programme of applied research will be undertaken to test certification in broader ecosystem applications, including carbon sequestration, biodiversity conservation and watershed protection. The paper will point out the necessary steps for implementation and outline required research.

Payment of environmental services (PES) is becoming a principal element in strategies for mainstreaming forest biodiversity conservation and maintaining essential support services. Nevertheless forest populations, often marginalised economically, derive little benefit from PES. The reasons postulated include bias towards large-scale forest operations, the complexity of market tools, and exclusion from participation.

An effective certification system can help to address some of these problems. As a market mechanism, it can help generate new sources of income for forest populations, while promoting biodiversity conservation and forest resources sustainability. It can facilitate responsible resource use and empower social and entrepreneurial organisations to achieve it. FSC certification gains over other more limited systems because of its extensive coverage and can bundle a range of forest products and services together in one evaluation, thus both saving costs and widening market opportunities.

For the reasons abovementioned, FSC and its partners have created an innovative project to test ES certification over a 4-year period. The project will be implemented in four pilot countries, Chile, Indonesia, Nepal and Vietnam.

Integral to the research is developing measurable compliance indicators for FSC standards. Such indicators at national level, while conforming to FSC principles and criteria, must relate to the diverse local conditions. Thus stakeholder participation in the process, including by marginalised communities, is essential. Moreover the indicators need to be based on sound scientific and practical bases, requiring expert advice. Therefore the involvement of experienced researchers is invited, not only for indicator development but also to consider market aspects.

Keywords: Forest management certification, FSC, indicators, participation, payment for environmental services, PES

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Soil fertiliy and nutrient cycling

Function and Nutrient Status of Sulphur in Oil Palm in Indonesia

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Sulphur (S) is indispensable for plant growth as S is a constituent of proteins, co-factors and in the form of sulphate esters a structural component of membranes. In recent decades the use of more concentrated straight and multi-nutrient fertilisers has led to a reduced S input from fertilisers in many regions of the world. Other important S inputs for agro-ecosystems, organic fertilisers and depositions from industrial pollution, are either of limited significance or not available.

In oil palm (OP) S has not been considered in nutrient management to any large extent, and in Indonesia S-free fertiliser regimes, consisting of urea, rock phosphate, KCl and dolomite, are frequently used. In addition, S losses by leaching are naturally high in the humid tropics suitable for OP cultivation. Hence, there is a potential risk of S supply being insufficient, but data that allow assessing the S status were not available. In the course of a BMP (Best Management Practise) project initiated by IPNI SEA in July 2006 comprising of 30 commercial-size blocks in six locations in Sumatra and Kalimantan (three sites each) the leaf nutrient status was assessed by analyses of frond #17.

A decline in the S status of the blocks receiving a typical fertiliser management (estate practise) was apparent at all six sites. In 2009 average leaf S levels of only 0.13 % (range: 0.11 - 14 %) were observed. It is argued that published critical S value (0.20 %) might be inflated. Therefore, the N/S ratio, frequently considered a more reliable indicator of the S status, was also evaluated. On average a ratio of 19/1 (range: 16.8 - 22.8 to 1) was obtained, strongly suggesting a S deficiency situation. Assuming a critical N/S ratio of 15/1 and a critical and adequate N concentration of 2.3 and 2.5 %, respectively, adjusted critical S concentrations of 0.15 and 0.17 % may be proposed. The S status of oil palm reported here is even below these adjsuted critical levels. Experiments are currently being initiated to (1) re-evaluate the critical S concentration and (2) assess the yield response to S supply at commercial block scale.

Keywords: Fertilisation, Indonesia, nutrient status, oil palm, sulphur

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Life Cycle Analysis of Biochar from Palm Oil empty Fruit Bunches

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One of the main residual products of the palm oil industry is the empty fruit bunch (EFB). For every tonne of oil palm fresh fruit bunch (FFB) that goes to the mills for processing and oil extraction, around 22 to 24 % is left over as EFB after steaming and removal of the fruits from the FFB. The EFB is partly incinerated at the mills, contributing to air pollution from palm oil production in Malaysia and Indonesia. In view of this impact, the Malaysian Environmental Air Quality Regulation prompts mills to implement alternative management methods for the disposal of the EFB. In some cases the EFB is spread as organic fertiliser under the tree of palm oil. However, carbon sequestration in soils using biochar from EFB is envisioned as a possible counter measure for mitigating and adapting to climate change, and converting EFB into a valuable product. Biochar is a stable carbon-rich product that results from heating biomass materials. There is a limited research of Life Cycle Analysis (LCA) of biochar from oil palm empty fruit bunch. The objective of this study is to assess energy balances and Global Warming Potential (GWP) of biochar production from EFB and its application in the field. We evaluated biochar production from EFB based on data obtained from a slow pyrolysis pilot plant operated in Malaysia. The products obtained from the slow pyrolysis of EFB are biochar (20 %), moisture (50 %), syngas (25 %) and bio-oil (5 %). We used the Life Cycle Analysis (LCA) methodology to trace and analyse the energy balance and GWP of biochar from EFB. The results indicate a positive energy balance of around 25 %. The analysis shows that CO_2 emissions, and to a lesser extend also N_2O and CH_4 emissions, are the main contributors to the global warming potential (GWP) of biochar production from EFB. The results indicate, that the GWP of biochar from EFB is much higher than the GWP discussed in other studies using wood as feedstock. This is mainly due to the intensive use energy (*i.e.* diesel and electricity) for operating the biochar production facility.

Keywords: Biochar, empty fruit bunch, global warming potential, greenhouse gas balances, GWP , LCA, oil palm, slow pyrolysis

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Fate of Particulate and Dissolved Organic Matter in Soil N Mineralisation

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The transformation of insoluble organic N via particulate and dissolved organic matter (POM and DOM) into inorganic N may represent the bottle neck mechanism in N mineralisation. However, it is unknown how POM fractions are related to DOM pools, and how these particulate and dissolved pools are quantitatively involved in N mineralisation. To understand and quantify the fate of these pools in N mineralisation, we conducted an incubation experiment with ^{15}N labeled radish residues to trace the flow of ^{15}N through the different N pools. POM was fractionated with density fractionation as light and heavy fraction (LF and HF). The dissolved organic matter fraction was collected using a centrifugal drainage technique and subsequently separated into a bioavailable and recalcitrant fraction. The enrichment of ^{15}N in POM, DON and inorganic N along with their concentrations were examined to identify their role in N mineralisation. Our analysis showed that neither DON nor POM function as a distinct N source fraction in soil. The collected DOM was predominantly recalcitrant (80 %), suggesting that the bioavailable DOM fraction cannot be measured with current sampling techniques. The concentration of DOM strongly increases upon incorporation of crop residues, but diminish sharply within a few days. Our results also suggest that the DOM fraction is heterogeneous in composition; the most bioavailable part is consumed within a few days whereas the remaining part is fairly constant. Moreover, the mineralisation rate of crop residue increased with incubation time but the ^{15}N enrichment of DON showed gradual decrease in time. The gradual decrease of ^{15}N enrichment in DON indicates that there was no change in their inputs. Hence these results suggested that a change in the turnover rate of DON was not associated with the N mineralisation rate of crop residue. From these results,we concluded that the main flow of decomposed N from residue did not pass or may not necessary to pass via the DON pool. Further research should focus on bioavailable fraction analysis.

Keywords: ^{15}N enrichment, bioavailable fraction, dissolved organic carbon, dissolved organic matter, dissolved organic nitrogen, particulate organic matter

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Gaseous Emissions from High and Low Input Homegardens of the Nuba Mountains, Central Sudan

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Positive horizontal nutrient balances for homegardens in the Nuba Mountains, Central Sudan, may lead to substantial nitrogen (N) and carbon (C) losses through leaching and gaseous emissions. This study therefore aimed to assess soil gaseous emissions of NH_3, N_2O, CH_4 and CO_2 using a mobile closed chamber system consisting of a Teflon®-film coated custom-made cuvette connected with a photo-acoustic infrared multi-gas monitor (INNOVA 1312–5). To capture variation in gas fluxes across different management systems and times of the year, temperature and different soil moisture levels, measurements were conducted in four case-study gardens, two low and two high nutrient input ones, over a period of seven months, including the rainy season. An agriculturally un-used area served as a control. Within each of these locations, twice a month six replicate measurements were collected in a vegetable and a cereal plot during the coolest (6–8 am) and the hottest (3–5 pm) hours of a day. Compared to the morning emissions, afternoon fluxes of all gases tended to be higher during the whole year, with the daily temporal variation being more pronounced after heavy rainfall events at the end of rainy season. Across the four gardens gaseous emissions reached their peaks at the onset (2748 g CO_2-C ha^{-1} h^{-1}) or during the rainy season (528 g CH_4-C ha^{-1} h^{-1}, 28 g NH_3-N ha^{-1} h^{-1}, and 13.7 g N_2O-N ha^{-1} h^{-1}). Cumulative N and C fluxes were substantially higher for the four gardens (49 to 57 kg N ha^{-1} yr^{-1} and 5.1 to 7.7 Mg C ha^{-1} yr^{-1}) than for the uncultivated control (44 kg N ha^{-1} yr^{-1} and 2.9 Mg C ha^{-1} yr^{-1}). The prevailing form of the N emissions was NH_3 (65 to 73 %), while CH_4 contributed only 7–16 % to total C losses. Effects of input intensity were not significant for C emissions from vegetable and cereal plots, but gaseous N losses from vegetable plots in gardens were with 58 to 68 kg N ha^{-1} yr^{-1} higher than from cereal fields (40 to 47 kg N ha^{-1} yr^{-1}).

Keywords: Carbon, closed chamber system, INNOVA, nitrogen, nutrient fluxes, photo-acoustic gas monitor

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Assessing the Sources of Biological Nitrogen Fixation in a Natural, Flooded Rice-field System using a Field $^{15}N_2$-labeling Technique

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The importance of biological nitrogen fixation (BNF) to the global nitrogen (N) cycle and plant nutrition is well-known, but common methods for BNF measurement are only qualitative and semi-quantitative. Exposing an intact soil-plant system to a $^{15}N_2$-enriched atmosphere in a natural environment could be the only direct method for quantifying BNF. We introduced a fully enclosed, automated growth chamber to estimate BNF using a $^{15}N_2$-labeling technique in a natural paddy rice field. The controlled growth chamber monitors simultaneously humidity, temperature and carbon dioxide concentration and continuously adjusts these parameters according to the environmental conditions. In this chamber, rice (*Oryza sativa* L.) growing in pots of flooded soil was exposed to a $^{15}N_2$-enriched (approx. 10 atom-%) atmosphere to assess BNF activities associated with rice. A non-enriched, $^{14}N_2$-incubation system was included as control. As limited knowledge is available about the BNF contribution of phototrophic, N_2-fixing bacteria, the surface of selected pots was covered by black cloth to manipulate specifically the activity of. After 70 days incubation, phototrophic blue green algae (BGA) from soil surface (0–1 cm) were obtained and subjected to isotope ratio mass spectrometry. Highest ^{15}N-enrichments were observed in BGA (2.9193 atom-% as opposed to 0.3703 atom-% in the $^{14}N_2$-control chamber). Their significant contribution to N input into flooded rice fields was further confirmed by the higher ^{15}N-abundance (0.7586 atom-%) found in the soil surface not covered with black cloth as compared to the covered soil surface (0.4387 atom-%). Our results provided evidence that the introduced $^{15}N_2$-labeling technique was suited to assess the sources and amounts of biologically fixed N in a natural, flooded rice-field system. To gain further insights into the ecology and actual contribution of N_2-fixing microorganisms in the highly complex soil/rice ecosystem, we will extend our studies by using molecular techniques to study the functional gene encoding nitrogenase (nifH gene), the essential enzyme required for BNF as performed by N_2-fixing microorganisms. This gene will be investigated in more detail by ^{15}N-DNA-based stable isotope probing and quantitative polymerase chain reaction techniques to identify those microorganisms actively contributing to BNF.

Keywords: $^{15}N_2$-labelling technique, biological nitrogen fixation, growth chamber

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Effects of Mycorrhiza and Plant Growth Promoting Rhizobacteria Inoculants on Rice Crops in Northern India

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Mutualistic root microorganisms such as arbuscular mycorrhizal fungi (AMF) and plant growth promoting rhizo-bacteria (PGPR) can ameliorate plant nutrition through an extended extra-radical hyphal network and by nutrient mobilisation. Running under the Indo-Swiss Collaboration in Biotechnology (ISCB), our project focuses on the integration of AMF and PGPR as bio-fertilisers in wheat-rice and wheat-black gram systems.

The inoculants were isolated and selected from wheat roots. AMF inoculation was performed with a natural consortium (Mnat) multiplied via host plants and comprising several AMF strains. In addition, two AMF single strains multiplied via a root organ culture were applied (an AMF strain isolated from Mnat and a commercial strain). The PGPR inoculum (Ps) consisted of two *fluorescent Pseudomonas* strains.

Effects of inoculants, presented here on rice crops (*Oryza sativa* [L.]), were assessed between 2006 and 2009 in a trial at Bhawanipur, Uttar Pradesh. The plots were managed at fertiliser level Zero (3 t ha^{-1} farmyard manure) and Farmer's Practice (FYM + mineral fertilisers), in the presence or absence of a *Sesbania* green manure intercrop before rice. Calculated across both fertiliser levels and over four years, rice grain yield was most increased by application of the dual inoculum "Mnat+Ps". Compared to the un-inoculated treatment, the yield was 22 % higher without and 30 % higher with *Sesbania*. This corresponds to an increase from 2.64 t ha^{-1} to 3.21 t ha^{-1} grain dry matter yield without *Sesbania*, and from 2.99 t ha^{-1} to 3.88 t ha^{-1} grain DM yield with *Sesbania* (means of four rice crops, $p \leq 0.001$). AMF single strains were less effective than Mnat. Phosphorus, zinc and iron concentration in rice grain was significantly increased in all inoculation treatments. The inoculants were effective both at Zero and Farmer's Practice fertiliser level.

Our results show that the bio-fertilisers tested have the ability to optimise rice crops in a wheat-rice rotation in India. Applying the same inoculants, Mäder *et al.* (Soil Biology & Biochemistry 43, 2011) obtained a wheat grain yield enhancement of 41 % compared to un-inoculated plots, suggesting that isolates from the rhizosphere of the target crop can even be more efficient.

Keywords: Inoculation, micro-elements, microorganisms, mineral nutrient concentration, mycorrhiza, PGPR, *Pseudomonas*, rice, *Sesbania*, yield

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Zero Tillage and Residue Level Impact on Carbon Dynamics in the Rice-Wheat Systems of the Lower Amu Darya Region, Uzbekistan

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Improved land management practice is a potential solution to increase productivity and long-term sustainability of land use systems. Conservation agriculture methods where combination of zero tillage with residue retention and introduction of alternate wetting and drying technique for growing rice can increase water productivity and soil quality. This study is based on the field research in a rice-wheat cropping rotation which was conducted during 2008–2009 in the Khorezm region of Uzbekistan. Studied treatments comprised of two tillage systems (zero tillage (ZT) and conventional tillage (CT)), two residue level retention (25 % and 100 %) and two irrigation methods (flooded and alternate wetting and drying). Indicators for soil biological processes such as soil organic carbon (Corg), permanganate oxidisable carbon (Cox), carbon management index (CMI), dehydrogenase activity (DHA), roots biomass and soil CO_2 borne respiration were investigated. Stratified soil sampling was followed through all seasons at four levels, from soil surface down to 30 cm. After three cropping seasons (rice-wheat-rice) results on Corg showed no significant difference between the treatments ($p < 0.05$). Root biomass at 0–5 cm depth was significantly higher in conventionally planted rice (3.68 mg cm^3), compared to conservation treatments (2.02 mg cm^3 (ZT100) and 2.41 mg cm^3 (ZT25)) and Corg was found to be positively correlated with root biomass (R=0.74). Soil physical conditions, such as anaerobic environment explained higher DHA of the soil at 0–5 cm depth and showed a significant difference of CT from ZT100 with values 222.18 and 189.27 μg INF g^{-1} soil day^{-1}, respectively. Based on CMI, CA treatments were about 20 % lower the CT. This confirmed the success of farmers' practice in management of soil carbon by incorporation of 25 % residues during tillage and a rather slow accumulation of soil C in CA treatments with no tillage. This study was an investigation of the potential pitfalls of CA as a potential upscaling technology and results will contribute in developing adapted fertiliser recommendations for farmers of the Khorezm region.

Keywords: Rice, Uzbekistan, wheat, zero tillage

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Improving Nitrogen Use Efficiencies in Rice-Wheat Rotations in Southeastern China

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Excessive use of mineral nitrogen (N) fertiliser is a common practice in rice-wheat rotations in southeastern China. At the same time the N use efficiencies (NUEs) in this rice-based cropping system are very low. The consequences are high N losses from arable land to water bodies (surface and ground water) and to the atmosphere. To investigate the scope and scale of reductions in mineral N fertiliser inputs, demonstration field experiments on farmers' field sites were conducted for three consecutive summer rice-winter wheat double crop rotations in the two counties Yixing and Huai'an in Jiangsu Province from 2008 to 2011. The experimental design was according to the so-called "3+x" approach with three different N fertilisation treatments ("conventional" (farmers' practice), "reduced" (by 25–30 %) and zero-N application) and two agronomical ("x") treatments within each N treatment. Effects on crop growth, crop N nutrition status, mineral N contents in the soil and soil solution as well as grain yields were determined and nitrogen balance sheets were calculated. In spite of the lower N fertilisation rate, no significant differences in crop growth, crop N nutrition status and grain yields were observed in the "reduced" N fertilisation treatments compared to the "conventional" N treatment in any year and crop over the three-year period. In contrast, a significant increase in NUEs could be achieved and the calculated N balances showed a clear decrease in nitrogen balance surpluses in the "reduced" N fertilisation treatments compared to farmers' practice. To summarise, we could demonstrate that the risk of N losses from arable land can be efficiently decreased by reducing the overall nitrogen fertilisation rate by approx. 25–30 % compared to local practice without any decline in grain yields of rice and wheat, and with a distinct increase in NUEs.

Keywords: Nitrogen balances, nitrogen fertilisation, nitrogen use efficiency, rice-wheat rotation

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Time of Sowing Sorghum (*Sorghum bicolor* L.) as Affected by Nitrogen Mineralisation from Farm Yard Manure in three Soil Types

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Synchronizing inorganic nitrogen during mineralisation of added organic matter with uptake by the subsequent crop is environmentally sound. In this study, laboratory and field experiments were conducted to estimate (in the first experiment) potential mineral N (NH_4-N + NO_3N) release pattern from farm yard manure (FYM) applied to three soil types and to determine (in the second experiment) the optimum time for sowing (one, two and three weeks after manure application) fodder sorghum (*Sorghum bicolor* L.) after application of the manure (10 t ha^{-1}). Potentially mineralisable N was determined by mixing farmyard manure with surface soil (0–30 cm) collected from sandy clay, clay loam and clay soils. The mixture was aerobically incubated for 12 weeks at about 70 % water holding capacity and mineral N was determined at a week interval time.

All amended soils immobilised N during the first week, but later net release of inorganic N occured. Maximum N mineralisation (14–15.6 % and 13.9 %) from added N were obtained after 9 and 7 weeks in the light and heavy textured soils, respectively. By the end of the incubation period, total net mineral N accumulated in the sandy clay, clay loam and clay soils were 91.7, 91.5 and 34.2 mg N kg^{-1}, respectively. In the light soils, sowing sorghum after two to three weeks from incorporation of manure gave significantly higher dry matter yields than after one week, whereas, in the heavy textured soil, sowing date had no significant effect. It could be concluded that adjusting sowing date, in light texture soils, of the subsequent crop after manure incorporation might improve yield.

Keywords: Farm yard manure, N mineralisation, soil type, sorghum, sowing date, synchrony

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Physiological Efficiency and Combined Effects of Phosphorus and Nitrogen from a Natural Source on the Yield of Maize in Humid Tropical Soil

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Cost reduction and an increased efficiency in the utilisation of nutrients are essential to establishing agricultural systems in the tropics. The objective of this study was to investigate the combined effects of calcined Al-phosphate and leucaena pruning on the agronomic and physiological use efficiency of nitrogen (N) and phosphorus (P) in maize. The treatments were as follows: 160 kg ha^{-1} P_2O_5 from Al-phosphate and 100 kg ha^{-1} of N from urea (Al-P+U); 160 kg ha^{-1} P_2O_5 from Al-phosphate and 6 Mg ha^{-1} *leucaena* dry matter residue (Al-P+L); 160 kg P_2O_5 from single super phosphate and 100 kg ha^{-1} of N from urea (SSP+U); 160 kg P_2O_5 from single super phosphate and 6 Mg ha^{-1} *Leucaena* dry matter residue (SSP+L); and a control without fertilisation. There was a beneficial association between the *Leucaena* and SSP on the growth of the maize, the N and P recovery and the agronomic efficiencies. Both ear weight and grain weight were higher under the SSP + L treatment than under the treatment SSP + U and higher under the Al-P + L treatment than the under the Al-P + U treatment. The low N and P agronomic efficiency in maize grown under the Al-P+U treatment made the combined use of these fertilisers unviable. The satisfactory efficiency of grain production showed by the maize grown under Al-P+L indicated that this treatment may replace processed fertilisers for agrosystems management in the tropics. In addition, these results also indicated that for an even greater increase in the productivity of cereals in tropical agrosystems, efforts should be undertaken to improve the soil rootability to accelerate the root growth to increase the nutrient recovery and dry-matter production before tasselling. At the same time, we must take advantage of the slow release of N by leguminous residues to ensure an adequate N uptake and maintain a high photosynthetic rate in the post-tasselling stage.

Keywords: Al-phosphate, *Leucaena leucocephala*, Low-input agrosystems

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Increasing Fertiliser Use Efficiency, Availability of Phosphorus and Crop Yield in Furrow Cultivation for Sustainable Agriculture on Sloping Land

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This experiment aimed to improve sustainable crop production on sloping land using lime, organic-fertiliser, inorganic-fertiliser, and zinc foliar application in cultivated furrow system. The experiment was designed as a split-split plot in completely randomised designed consisted of 3 replicates. Main plots were cultivated systems comprising conventional planting (CP) and cultivated furrow (CF). Sub plots were foliar zinc (Zn1) and no zinc (Zn0) applications. Sub-sub plots were applications of lime (L), organic fertiliser (OF), and inorganic fertiliser (IF) including control (no lime and no fertiliser). Lablab bean (*Lablab perpureus* L.) was grown after maize (*Zea mays* L.) during late rainy season – dry season. Soil properties were measured monthly during lablab bean growing, using conventional standard methods. The soil properties were bulk density (BD), particle density (PD), total porosity (TP), field capacity (FC), aeration porosity (AP), soil acidity (pH), organic matter (OM), extractable phosphorus and zinc (Ext.P and Ext.Zn). Crop developments were measured as plant height every month. Total dry biomass, seed yields, total phosphorus and zinc (Total P and Total Zn) in plant tissue were measured after crop harvesting.

The results showed that CF significantly gave better soil properties, crop growth and yields than CP. Foliar Zn application gave higher crop growth, total dry biomass, yields, and total plant P than without Zn application. There were interaction effects of cultivation practice and application of L, OF, and IF on Ext.P and crop growth. IF and OF application in CF gave the highest and 2nd high of Ext.P-values compared with either L or control. While, applying IF in CP gave the lowest Ext.P compared with either OF or L. This might be caused by loss of fertiliser through runoff and soil erosion. In addition, applying of OF and L tended to increase soil pH, OM, and Ext.P. This improvement led to significantly increased crop growth and yield. The result indicated that application of fertilisers, lime and foliar zinc spray in furrow cultivation were the best strategy for increasing fertiliser use efficiency and crop yield on sloping land.

Keywords: Furrow cultivation, phosphorus availability, sloping land

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Examining Nitrogen Dynamics in an Upland Rice-*Stylosanthes guianensis* Based Conservation Agriculture System Using ^{15}N Stable Isotope Techniques

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The ferralitic soils of the Malagasy highlands have low fertility and become more and more degraded as continued conventional cropping based on soil tillage results in nutrient depletion through nutrient mining and soil erosion. Conservation agriculture, which comprises minimal soil disturbance, permanent soil cover and crop rotation, often includes legumes as cover or inter-crop to enhance soil fertility through a possible biological nitrogen (N) fixation-benefit. Since more than a decade, conservation agriculture has been introduced on Madagascar as an alternative for small scale farmers. One of the legumes propagated in local up-land rice production systems is *Stylosanthes guianensis*. Yet, little research has been done looking at the nutrient N flows in such a system of low input conservation agriculture. How do soil and residue management (tillage vs. direct seeding) influence N flows and dynamics, in a situation where soils are highly P deficient. How do these conditions affect the N use efficiency in this system, when applying different fertilisers (mineral, legume residues and manure) and how can the input of atmospheric N fixed by the legume be maximised to spare mineral fertiliser N inputs? Our aim is thus to characterise the nutrient N flows, dynamics and the N use efficiency by rice in order to optimise the N input by the legume *Stylosanthes guianensis* to the system. Hereby we will compare and examine conservation vs. conventional agricultural practices applied in an upland rice-*Stylosanthes guianensis* based agricultural system, using ^{15}N direct and indirect labeling stable isotope techniques. Expected outputs are the quantification of symbiotic N_2 fixation of stylo, quantification of uptake and recovery of N by rice from different N-sources (legume residues, manure, mineral fertiliser N) and to monitor and quantify soil N dynamics. In the poster we present the concept, design and methodological approaches of the study.

Keywords: Biological nitrogen fixation, conservation agriculture, ferralitic soils, Madagascar, stable isotope, *Stylosanthes guianensis*, upland rice

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Manure Application Improves Phosphate Fertiliser Effectiveness through Enhanced Biological Cycling of Phosphorus

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High phosphate fixation necessitates the application of high rates of P fertilisers in order to achieve reasonable crop yields in most tropical soils. This study investigated the effectiveness of goat manure in improving the effectiveness of fertiliser P to improve maize yields. Treatments consisted of combinations of four rates of goat manure (0, 2.5, 5 and 10 g kg^{-1}) equivalent to 0, 5, 10 and 20 t goat manure ha^{-1}, respectively and four rates of inorganic P (0, 45, 90 and 180 mg P kg^{-1} equivalent to 0, 90, 180 and 360 kg P ha^{-1}, respectively) applied to 7 kg soil in pots. Maize (*Zea mays* L.) was sown immediately thereafter. Maize dry matter yields and concentrations of resin-P, soil microbial biomass P (biomass P), 0.5 M NaHCO3 extractable inorganic P (NaHCO3-Pi), and 0.1 M NaOH extractable inorganic P (NaOH-Pi) were determined at 6 and 12 weeks after planting. After 12 weeks, maize dry matter yield (maize yield) was increased by addition of fertiliser P or goat manure separately and was further increased when they were applied together. These synergistic effects on maize yield was ascribed to enhanced P cycling since goat manure increased the concentration of biomass P which in turn accounted for most of the observed variations (63 %) in maize yields. The combination of biomass P and resin P, however, explained a greater proportion of the variations in maize dry matter yield (73 %) suggesting that the usefulness of biomass P as an index of P availability would be enhanced if used in conjunction with resin P. These results indicated that goat manure application could be used to increase soil microbial biomass P, which, in turn, could improve the effectiveness of fertiliser P in the Eastern Cape, South Africa.

Keywords: Biomass P, goat manure, inorganic P, P cycling, resin P

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Lignin Dynamics and Abundances of ^{13}C and ^{15}N in Secondary Pasture Soils after Land Use Change in the South African Highveld

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Converting degraded cropland to permanent grassland is a strategy to combat desertification and to promote sequestration of soil organic carbon (SOC). The objective of this study was to elucidate the contribution of lignin to SOC accrual in secondary pasture soils (1 to 31 years old) at three agro-ecosystems in the semi-arid Highveld of South Africa. Old degraded croplands and primary grassland used as pastures served as the controls. Topsoil samples (0–5 and 5–10 cm; Plinthustalfs) were characterised by their natural ^{13}C and ^{15}N abundances and their contents of lignin-derived phenols (VSC). The results showed that the soil $\delta^{13}C$ signature was variable and not a sensitive indicator of land restoration in these C4 dominated grassland sites. However, soil $\delta^{15}N$ values declined from 8 to 6 ‰ with increased duration of secondary pasture use and approached there with the values of the N cycle in the primary grassland. The VSC contents increased in the surface soils and reached a new steady-state equilibrium after 38 years. Lignin sequestration was accelerated relative to other SOC constituents in the 0–5 cm soil depth but delayed in the 5–10 cm soil depth, reflecting different depth-dependent inputs of plant debris in the grassland. Yet, even in the oldest secondary pasture absolute lignin contents remained lower than in the primary grassland, which, however, also exhibited a slightly finer soil texture. In contrast, the lignin proportions of total carbon (g VSC kg^{-1} C) approached those of the primary grassland,*i.e.*, they increased in the 0–5 cm soil depth and decreased in the 5–10 cm soil depth. Decreasing ratios of syringyl or cinnamyl to the vanillyl structural units (S/V and C/V ratios) reflected that the restored lignin derived primarily from the new grassland vegetation. The degree of lignin side chain oxidation did not reveal a clear trend along the chronosequence. We conclude that only initial stages of SOC sequestration were hampered by an efficient storage of plant residues. After 2 decades, however, lignin co-accumulated with bulk SOC, with little changes in lignin oxidation rates at the restored secondary pastures relative to the primary grassland sites.

Keywords: Land restoration, land use change, lignin, secondary pastures, soil organic carbon sequestration, stable isotopes

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Horizontal Nutrient Flows and Balances in Irrigated Urban Gardens of Khartoum, Sudan

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The role of urban and peri-urban agriculture (UPA) for the supply of fresh vegetables, fruits and meat for local markets is well-known. The periodically flooded Gerif soils on the River Nile banks in the core of Khartoum city harbour vegetable gardens that supply perishable leafy vegetables with a short life cycle. In an effort to assess their sustainability and possible negative environmental externalities we used a horizontal balance approach (total outputs minus inputs for N, P, K and C) to determine the nutrient use efficiency of four intensively cropped UPA gardens. Two of the gardens were located in downstream lowlands (L1 & L2) and the other two belonged to the upstream highlands (H1 & H2). Deposits of river sediments were estimated to contribute 752, 994, 389 and 189 kg N ha^{-1}, 5, 8, 2 and 1.1 kg P ha^{-1}, 7, 6.5, 4 and 1 kg K ha^{-1} and 6 943, 9 691, 2 760 and 1 116 kg C ha^{-1} for gardens L1, L2, H1 and H2, respectively. Taking into account management related fluxes, yielded positive horizontal balances for N and C and negative balances of P and K. These were estimated at 1 553, 1 508, 969 and 745 kg N ha^{-1} yr^{-1}, 19 410, 17 772, 9 949 and 3 201 kg C ha^{-1} yr^{-1}, -4, -29, -36 and -0.9 kg P ha^{-1} yr^{-1} and -8,055, -6,181, -4,886 and -450 kg K ha^{-1} yr^{-1} for garden L1, L2, H1 and H2, respectively. While the River Nile floods contribute significantly to soil fertility maintenance, the negative P and K balances call for a better integration of UPA gardening with livestock husbandry and the regular addition of animal manure in these cropping systems.

Keywords: Gerif soils, nutrient fluxes, sediment deposits, soil nutrient status

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Nutrient Balances and Gaseous Emissions of Nitrogen in Urban Vegetable Gardens of Bobo Dioulasso, Burkina Faso

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In sub-Saharan Africa urban and peri-urban agriculture (UPA) is an important livelihood strategy for the urban poor and contributes to meeting increasing demands for food in the rapidly growing cities. Although in recent years many research activities have been geared towards enhancing the productivity of this land use system, little is known about the efficiency of UPA. The aim of our study therefore was to investigate nutrient management practices in urban vegetable gardens of Bobo Dioulasso. A nutrient-balance approach was used to determine nitrogen (N), phosphorus (P) and potassium (K) fluxes and balances from March 2008 to March 2009 for two production systems classified as: the commercial gardening + field crops and livestock system (cGCL) and the commercial gardening and semi-commercial field crop system (cGscC). Simultaneously, ammonia (NH_3) and nitrous oxide (N_2O) emissions from the respective soils were measured during the coolest and the hottest periods of the day using a closed chamber system. Our results show that N, P and K input rates in both systems exceeded the rates recommended by the National Extension Service by 236 %, 33 % and 187 % for N, P and K, respectively. This resulted in annual positive balances reaching 1,153 kg N ha^{-1}, 339 kg P ha^{-1} and 76 kg K ha^{-1} for the cGCL system and 711 kg N ha^{-1}, 334 kg P ha^{-1} and 82 kg K ha^{-1} for the cGscC system. The highest emission rates occurred during the hot mid-days and the peaks were observed after fertiliser applications reaching fluxes of up to 1,140 and 154 g ha^{-1} h^{-1} for NH_3-N and N_2O-N, respectively. The estimated total annual losses of N reached 419 and 347 kg ha^{-1} for cGCL and cGscC systems. This accounted for 36 % and 49 % of the N surpluses in cGCL and cGscC. NH_3 accounted for 73 % and 77 % of the total estimated N losses for the cGCL and the cGscC. The study indicates that nutrient management practices in UPA vegetable production in Bobo Dioulasso would greatly benefit from better synchronising nutrient input rates with crop demand and adjusted fertilisation techniques to mitigate N losses.

Keywords: Closed chamber system, horizontal and vertical nutrient fluxes, urban agriculture, West Africa

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A Microcosm Experiment to Assess Microbial Process as Determined by Different Biochemically Organic Residues

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Biochemical composition of organic residues whose quality is partly defined by their content of organic N (Norg), and polyphenols (PP), influences the accumulation of soil organic matter (SOM) and the still poorly understood soil microbial decomposition processes. A better understanding of these microbial processes, through the study of microorganisms involved in residue decomposition and their functional attributes, is crucial to maintain soil productivity in tropical ecosystems. To provide complementary information on how organic residue quality influences soil microbial properties, we reverted to a long-term field experiment in Thailand in which the effects of biochemically different organic residues such as rice straw (RS; Norg content: 4.7; PP content: 6.5 g kg^{-1}), groundnut (GN; 22.8; 12.9), tamarind (TM; 13.6; 31.5), and dipterocarp (DP; 5.7; 64.9)) on SOM dynamics are studied since 16 years. It was of particular interest how microbial processes in soils which have received these residues since 16 years (native soils, N-soil) were altered as compared to those that did not receive any residue material during the same period (control soil; C-soil). Soils were taken from the field experiment and incubated in microcosms with the following treatments: N-soil was mixed with either residue (*e.g.* N-soil treated with RS since 16 years plus fresh RS (NRS+RS), NGN+GN, NDP+DP, NTM+TM) or left untreated (NRS, NGN, NDP, and NTM), while C-soil was mixed with either residue (C+RS, C+GN, C+DP, and C+TM) or left untreated (CON). After 56 days incubation, soils were analysed for soil microbial biomass carbon (MB-C) and its function (cumulative carbon dioxide evolution (CO_2-C) as well as activities of invertase, β-glucosidase and phenoloxidase. Results showed that MB-C, CO_2-C, as well as activities of invertase and β-glucosidase in residue treated N-soils tended to be higher than those in residue-treated C-soils, while the opposite was found for phenoloxidase activity. The effect of residue quality was most pronounced for residue-treated C-soils in which phenoloxidase showed highest activity after DP addition, while activities of invertase and β-glucosidase were promoted in TM- and GN-treated N-soils. These results indicated that 16 years of continuous residue addition led to a general increase of soil microbial processes in N-soils, but the most obvious residue quality effect was determined for microbial polyphenol oxidation in C-soils treated with DP, probably because of its high polyphenol content. We could prove that long-term addition of biochemically different residues shaped soil microbial processes, but it still needs to be elucidated why C-soils showed a similar reaction like the N-soils and why polyphenol oxidation appeared to be particularly pronounced. For further investigation, we will apply molecular techniques to identify those specific microbial community members actively involved in polyphenol oxidation.

Keywords: Long-term field experiment, organic residue quality, soil microbial processes

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Performance of Farmland Terracing in Maintaining Soil Fertility in South Wello, Northern Highlands of Ethiopia

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Soil erosion induced land degradation is a prominent challenge in sub-Saharan Africa countries. The problem is threatening livelihood of subsistent farmers of Ethiopia particularly in the highlands. Soil and water conservation interventions like farmland terracing have been implemented to reduce the impact of soil erosion and halt land degradation. However, terracing has been criticised for development of soil fertility gradients as well as its temporal and spatial variability. The study was conducted in Lake Maybar watershed, South Wello in northern Ethiopia to provide quantitative information on the aforementioned issues. Soil samples collected from 16 plots in four slope categories, in three terrace positions and four replicates were analysed for major soil physical and chemical properties using standard laboratory procedures.
Results of the analyses showed that farmland terracing brought clear differences on different positions of the landscape. Soil reaction, exchangeable bases and clay content significantly ($p < 0.03$, $\alpha = 0.05$) decreased with slope of terrain. Soluble salt eroded and leached from upper slope was accumulated at the lower slope as water got more residence time so that suspended salt precipitates. On the other hand, comparison of soil fertility within a terrace depicted no significant differences for most soil physico-chemical properties except bulk density. Soil fertility after two decades of farmland terracing showed nearly stabled conditions with only very slight change. Terracing reduced soil and soil nutrient loss through erosion but it did not completely stop erosion. In order to maintain soil fertility status, soil nutrients exported through crop harvest and residue removal should be compensated by use of organic and inorganic fertiliser. Generally performances of farmland terracing to maintain soil fertility vary with space and time. In order to optimise the impact of farmland terracing on soil fertility maintenance, terracing should be accompanied by different land management practices depending on the specific conditions.

Keywords: Ethiopia, soil degradation, soil fertility, terracing

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Maintenance of Soil Quality in an Intensive Horticultural System in the Highlands of West Java

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Intensive vegetable production on Andosol soils in the humid highlands of West Java (Indonesia) meets most of the domestic demand for vegetables. Permanent cropping, tight crop rotations and nutrient exports may result in soil degradation if best practice soil fertility management is not used.

To verify this hypothesis, eight farms near Lembang and Pangalengan were surveyed (April to July 2010) for their management practices with soil quality assessed. Farmers were interviewed about their practices and surface soil samples were collected from a range of vegetable beds. Nearby afforested sites, formerly used for vegetable production, were sampled to provide a baseline. The following indicators of soil quality were analysed: organic carbon (OC) (Walkely-Black), total nitrogen (TN) (Kjeldahl), available phosphorus (Bray-II) and bulk density (BD). In addition, soil texture, CEC and pH were analysed, but not presented. Differences between the two land use systems were evaluated by t-test.

According to the interviews, management practices include the use of plastic mulch, large applications of manure (5 t ha^{-1} crop), mineral fertiliser ($>$ 100 kg NPK_2O fertiliser (25.1/12.2/6.5) ha^{-1} crop) and the regular application of pesticides.

OC (21.8 %) and TN (0.62 %) are significantly higher in the afforested sites than in the vegetable beds (15 % and 0.47 %). The difference can be explained by the accelerated mineralisation in vegetable beds due to tillage. The extremely high OC values are perhaps the result of protection by organo-metallic associations in these Andosol soils. The incorporation of large amounts of rice husks (C/N ratio $>$ 80) into the manure which is applied may also result in OC concentrations. Due to fertilisation, the amount of available phosphorus is higher in the vegetable beds (38 mg kg^{-1}) than in the afforested land (11 mg kg^{-1}). BD shows no significant difference between the vegetable (0.73 g cm^{-3}) and the afforested land (0.68 g cm^{-3}). The construction of raised vegetable beds with large amounts of organic material is proposed as the reason that no differences in BD were found.

This survey showed that high applications of organic amendments and mineral fertilisers resulted in the maintenance of soil fertility, but the wider implications of high input intensive systems are discussed further.

Keywords: Horticulture, Indonesia, organic carbon, soil quality

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Litterfall and Nutrient Deposition in a Microphylous Shrubland Desert Community, Northeastern Mexico

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The objective of this study was to determine the litterfal production and the macro- (Ca, K, Mg, and P) and micro-nutrient (Fe, Mn and Zn) deposition through leaf litter in two research sites of similar vegetation type site 1: La Soledad (1863 m a.s.l.), Galeana county, Nuevo Leon sate, and site 2: San José del Alamito (1895 m a.s.l.), Saltillo county, Coahuila state, Mexico. The main vegetation type is a microphylous desert shrubland. Litter constituents (leaves, reproductive structures, twigs and miscellaneous residues) were collected at 15-day intervals from September 2008 to August 2009. Collections were carried out in 10 litter canisters (1.0 m $\times$ 1.0 m) randomly situated at an previously experimental plot of about 2500 m^2. Total annual deposition was 1,621 and 4,070 kg ha^{-1} y^{-1} for La Soledad and Alamito, respectively. Of total annual litter production, leaves contributed from 53 % (La Soledad) to 50 % (Alamito) followed by twigs from 25 % (Alamito) to 20 % (La Soledad), reproductive structures from 21 % (Alamito) to 19 % (La Soledad), and miscellaneous litterfall from 7 % (La Soledad) to 4 % (Alamito). Ca annual deposition was significantly higher in La Soledad (51.7 kg ha^{-1} y^{-1}) than Alamito (38.4 kg ha^{-1} y^{-1}). K annual deposition for Alamito and La Soledad was 79.3 and 58.4 kg ha^{-1} y^{-1}, respectively, Mg was 401.4 and 396.4 kg ha^{-1} y^{-1}, P was 681.2 and 680.5 kg ha^{-1} y^{-1} for Alamito and La Soledad, respectively. The micro-nutrient annual deposition was for Fe was 540.9 and 217.6 mg ha^{-1} y^{-1}; Mn 119.3 and 41.3, and Zn 57.4 and 16.9 mg ha^{-1} y^{-1} for Alamito and La Soledad, respectively. The results showed a higher nutrient deposition at the Alamito site and this could be related to the structure of the plant community on this site, along with spatial and temporal trends of leaf litter input.

Keywords: Litter, litterfall, northeastern Mexico, nutrient deposition

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Effect of Mass Movements and Climate on Natural Soil Fertility in Mountainous Ecosystems of Monsoonal Vietnam and Humid Tropical Indonesia

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Knowledge about the natural state of soil fertility is crucial for quantifying climatic effects or naturally occurring mass movements. There is a lack of data about soil fertility parameters in natural state in steep slopes of mountainous ecosystems of Southeast Asia. Deforestation and subsequent cultivation reduce the remaining primary forest areas with pristine soils. We selected 5 sites in monsoonal northwestern Vietnam and 10 sites in humid tropical Indonesia. Our aims were to find out (1) how soil fertility parameters differ between the two climatic regions and (2) if naturally occurring mass movements in Indonesia have an effect on soil fertility . Soil profiles have been described and analysed horizon wise until 1 m depth. Soils in Vietnam are Luvisols, Alisols and Vertisols. Undisturbed Indonesian soils are Ferralsols, Acrisols and Lixisols. Mass movement affected Indonesian soils are mostly Cambisols. Most soil fertility parameters were significantly higher in Vietnam compared to Indonesia: Clay content 61 %, stocks of organic C 37 %, stocks of total N 30 %, stocks of exchangeable Ca^{2+} 87 % and Mg^{2+} 70 %, cation exchange capacity 78 %, base saturation 30 % and pH value 1,5 units. Only stocks of exchangeable K^+ were higher in Indonesia (33 %) than in Vietnam. Mass movements under primary forest significantly favoured some of the investigated soil fertility parameters: In mass movement affected soils significantly higher base saturation (60 %), higher pH value (1,3 units), higher stocks of Ca^{2+}(72 %), higher sand contents (21 %) as well as lower clay contents (21 %) were found compared to undisturbed Indonesian soils. Stocks of Mg^{2+} and K^+ were higher in mass movement affected soils than in undisturbed soils, however, not significantly. No effect of mass movements was detected for stocks of C and N. This study highlights the climatic benefits and constraints of the two studied regions as well as the beneficial effects of mass movements for soil fertility. Mass movements keep the soils young due to mixing old soil with weatherable minerals. Their wide spread occurrence throughout the tropics should be considered more when discussing about soil fertility in natural state.

Keywords: Climate, land slide, mass moovement, mountain, primary forest, soil

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Soil Properties under the Influence of Different Rangeland Management in the Grassland Biome, South Africa

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The grassland biome of South Africa is a major resource for livestock farming; yet, the soils of these rangelands are increasingly threatened by overgrazing. The aim of the present study was to investigate how basic soil properties respond to intensified rangeland management under different property rights. For this purpose we sampled different types of rangeland management systems under communal, trust and commercial farming, and within each of these systems we differentiated good, moderate and poor rangeland conditions along a gradient of increasing grazing pressure with decreasing distance to the drinking points. The analyses comprised the assessment of C, N and inorganic nutrient contents as well as the determination of amino sugars as markers for microbial residues. The results showed that soils from the commercial farms exhibit higher nutrient contents, especially those of C, N and K were enriched, whereas the respective nutrient stocks were depleted in the communal farms. When separating the samples into the different veld conditions (poor, moderate and good) we found that the change in soil properties of communal farms took place mostly in the poor veld. The poor rangeland condition was also depleted in microbial residues, among which fungal residues (glucosamine) dominated the microbial residue pattern. We conclude that soil degradation with intensified rangeland management occurs mainly nearby the watering points, but that the management system has a great impact on the direction of these changes. Under communal management, the soils of the poor rangeland condition degrade, whereas under commercial management the soils even improve, likely as a result of longer soil resting times and additional use of feed additives.

Keywords: Livestock farming, microbial residues, soil nutrients, veld condition

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Quantification of the Variability and Pattern in Total Element Composition of sub-Saharan African Soils

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Measuring total element concentration of soils using conventional methods is time-consuming. Total X-ray Fluorescence Spectroscopy (TXRF) provides for rapid and simultaneous determination of the concentrations of most elements from sodium to Uranium with minimal sample preparation time. The technique opens up the possibilities for using total element profiling to improve global predictions of soil functional properties, such as soil organic carbon, cation exchange capacity, extractable nutrients, P sorption, water holding capacity, and soil stability. In this paper we present our investigations of the quantification of the variability and patterns in total element composition of soils from eight 100-km^2 sites across sub-Saharan Africa: Tanzania (3 sites), Congo (2 sites), Mali (2 sites), Burkina Faso (1 site). Paired topsoil and subsoil samples taken from 32 randomised sample points at each site were analysed. We explored the within and between site patterns of variation in total element composition and their relationships with directly measured soil functional properties and TXRF soil spectral properties using scatter plots, principal component analysis, and classification and regression trees in R statistical software. The results indicate that TXRF provides chemical fingerprinting that relates to potential soil nutrient supply capacity. There were also relative variations in total element composition within and between the sites analysed. Thus TXRF can be used as a complementary input to pedotransfer functions for low cost, rapid prediction of soil functional properties. TXRF could also provide improved capabilities, for improving advisory services on soil constraints to plant growth with subsequent benefit to food security and human health.

Keywords: Soil functional properties, total element composition, TXRF

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Assessment of Supply of Soil Nutrients in Different Land Use Types Using Plant Root Simulator Probes

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The study was conducted in 2009 in Tara Gedam and Ambober watersheds of Northwest Ethiopian highlands to assess the plant available soil nutrients for different land use types. The plant root simulator (PRSTM) probes which consists of an ion extraction membrane encapsulated in a plastic probe were buried in the soil at a depth of 10 cm in a root exclusion cylinder in agriculture, forest (community protected and church forests at Tara Gedam and community protected forest at Ambober) and grazing lands in three or more replicates. After an exposure of six weeks, the probes were sent to Western Ag Innovations, Canada for laboratory analysis (NH_4^+-N, Ca, K, Mg, NO_3N, P, S, Al, Fe, Mn, Cu, Zn, and B). ANOVA and subsequent multiple comparison using Scheffe test ($p<0,05$) showed that total nitrogen, nitrate nitrogen, iron, manganese, copper, zinc, and boron supply in church forests was significantly higher than in community protected forests, grazing and agriculture lands. No significant difference for ammonium nitrogen, magnesium, potassium, phosphorus, sulphur and aluminum was found among the land use types at Tara Gedam. The maximum nitrate nitrogen supply was recorded for soils under church forest (682.7±85.8 μg 10 cm^{-2}/6 weeks) followed by community protected forest (149.4±70 μg 10 cm^{-2}/6 weeks), grazing land (137.9±54.3 μg 10 cm^{-2}/6 weeks) and the lowest value for agriculture land (69.9±40.4 μg 10 cm^{-2}/6 weeks) at Tara Gedam. At Ambober, nitrate nitrogen supply was significantly different only between community protected forest (215±45.2 μg 10 cm^{-2}/6 weeks) and grazing land (33.2±45.2) and no significant differences among the other land use types and other nutrients. The supply rate of potassium, boron and aluminum was significantly higher at Tara Gedam compared to Ambober while, the reverse is true for sulphur and magnesium. The interaction of watershed and land use types showed significant difference for the supply of total nitrogen, nitrate nitrogen, calcium, and boron. The study indicated that in a well managed church forest the supply of most soil nutrients was significantly different from the exhaustively used land use types indicating the need for sustainable nutrient management.

Keywords: Land use, nutrient, PRSTM probes, supply, watershed

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Agronomic Effects of Biochar and Polyphenols as Compost Additives to Irrigated *Raphanus sativus* in Oman

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Under irrigated dryland conditions maintaining soil organic matter and closing nutrient cycles is particularly important for sustainable cropping. In organic farming compost has been used successfully to supply nutrients to crops and to support efficient nutrient cycling through microbial biomass. However, under (sub-)tropical conditions, the efficacy of compost amendments maybe offset by high decomposition rates. To alleviate this problem biochar added as a soil conditioner and / or polyphenols from locally available plant materials could be used as mineralisation inhibitors to enhance plant growth and crop yield. The main objective of this study therefore was to investigate the effects of biochar and polyphenols as additives to composts on the chemical properties of soil, on plant growth and root yield of radish (*Raphanus sativus* L.). These additives were applied singly and mixed (50% each) to compost at two different processing stages; (i) before the composting process and (ii) after processing by mixing additives with mature compost before application to the soil. Both additives were tested in a pot experiment with five replicates whereby the amended compost treatments were compared to an unamended compost and an equivalent application of mineral fertilisers at a level of 135 kg N ha^{-1}.

Total plant dry matter production was highest (5 t ha^{-1}) for the combined application of biochar and polyphenols applied before the composting process and lowest (3.4 t ha^{-1}) for compost treated with only polyphenols (3 %) before the composting process. The mixed combination of biochar and polyphenols applied at 1.5 % w/w to compost led to highest root yields (2.2 t ha^{-1}) compared to the unamended compost (1.3 t ha^{-1}) and mineral fertiliser application (1.2 t ha^{-1}). In comparison to the mineral fertiliser application the dry matter root / shoot ratio (1:2.6) was significantly higher for compost with biochar (1:1.4) and for biochar and polyphenol addition after composting (1:1.2). The combination of charcoal and polyphenols addition thus seems to have potential to improve the growth and yield of radish.

Keywords: Biochar, compost, Oman, organic agriculture, polyphenols

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Influence of Biochar and Tannin Amendments to Goat Manure on Gaseous C and N Emissions

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In subtropical irrigation agriculture year-round high temperature and soil moisture lead to high microbial turnover of organic matter and thus potentially high losses of nitrogen (N) and carbon (C) by gaseous emissions. To investigate the effect of biochar and tannin amendments to manure on gaseous losses of N and C, an incubation experiment was conducted in a climate chamber over 10 days during which air temperature and humidity were kept at 30°C and 50 %, respectively. Soil moisture was adjusted every 24h to 60 % field capacity. Goat manure was amended with biochar and tannins at two different concentrations through addition (i) to the goat feed and (ii) directly to dried goat manure, before its application to the soil at a rate equivalent to 0.25 and 0.8 t biochar ha^{-1}, and 0.4 and 1.0 t tannins ha^{-1}. Soil emissions of NH_3, N_2O and CO_2 were measured for the amended and unamended manure treatments and for pure soil using a closed chamber system connected to a photo-acoustic infrared multi-gas monitor.Maximum N_2O flux rates varied from 0.62–1.06 mg h^{-1} m^{-2} and were only decreased for tannins fed to goats by 42 % compared to unamended manure (control). Despite this, flux rate peaked 48hrs later for tannins mixed to manure compared to the control treatment and, in contrast, 72hrs earlier for biochar fed to goats. Total N emissions, (60 % as N_2O-N and 40 % as NH_3,-N) ranged from 42–78 g m^{-2} $10d^{-1}$. Emission peaks of CO_2 were not temporally shifted, but distinctly lowered by biochar (42 %) and tannins (20 %) fed to goats compared to the control treatment. In contrast, direct addition of biochar and tannins to manure enhanced CO_2-C by 14 and 24 %, respectively. Total C emissions ranged from 40–75 g m^{-2} 10 d^{-1} (97 % as CO_2-C). CH_4 and NH_3 emission rates and cumulative emissions of all manure treatments did not differ from emissions of the pure soil. The causes of the contrasting effects of the two application modes of biochar and tannins on CO_2 and N_2O emissions merit further research.

Keywords: Biochar, carbon, gas emissions, nitrogen, tannin

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Wood Ash Microdosing as Fertiliser Strategy for Subsistence Oriented and Resource Poor Sahelian Farmers?

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Agriculture in the Sahel is still dominantly subsistence oriented. Though market orientation needs to be developed in the long-term in order to increase income, also strategies for the marginal resource poor farmers are requested to assure food security. One successful strategy developed in 1990ies was fertiliser microdosing, meaning placed application of fertiliser close to the seeds in the wide spaced planting scheme as it is frequent *i.e.* for pearl millet under Sahelian conditions.

Given the still difficult access to fertiliser for many Sahelian farmers and the high price fluctuation during the last years, an alternative was searched for in the frame of the BMZ financed CODE-WA R4D project. After testing several options including local rock phosphates, wood ash was chosen as most promising.

Using a multidimensional experimental approach, which was developed especially for this purpose with the dimensions scale, crops, and management the wood ash technology was developed, tested and evaluated within one year. Success of the technology depends on the four factors soil texture, soil fertility, crop type, and timing of application. Received rainfall and rainfall distribution may influence also the crop response to ash. Applied at sowing to small grain cereals like pearl millet and sorghum it increases yield variables; applied at flowering to legumes it increases quality (grain size, *Aspergillus* infection, aflatoxin contamination).

Target groups are specifically women, since they are at the source (fire wood consumption in the household) and usually crop less surface (restricted wood ash availability) on the least fertile land (highest effect).

Keywords: Fertiliser, gender, multidimensional experiment approach, Sahel, woodash

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Effect of Urine and Ammonium Nitrate Rate on Maize (*Zea mays*) Grown on Saline and Non-saline Soils

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Urine is inherently saline and despite recent advancement in urine fertiliser research, little is known on its effect on crops under saline soil conditions. Our study aimed at investigating the effect of urine and ammonium nitrate nitrogen rates on maize (*Zea mays* L.) plant performance (leaf area, wet and dry weight yield and height), leaf concentration of N, P, K, Na, Mg and Ca. The experimental setup was a completely randomised block design with 3 salt levels, 2 fertilisers and 2 rates of N application. Salinity was induced by adding NaCl to a soil substrate of compost, loam and quartz sand to achieve target salinities of 0.6, 1.6 and 3.2 dS m^{-1}. Nitrogen doses were 0.18 and 0.36 g kg^{-1} soil. Basal P and K of 0.18 and 0.27 g kg^{-1} of soil was added as mono potassium phosphate. Salinity increased leaf N, P, Na, Ca and reduced K while Mg remained unaffected. Leaf nitrogen and Ca contents were higher with urine than ammonium nitrate-fertilised plants. Salinity significantly reduced crop leaf area but there was no N rate or source effect. Under saline conditions, shoot fresh and dry matter was reduced by up to 40 % when urine was used instead of ammonium nitrate. A 5-fold increase in soil salinity was measured on urine-fertilised soils. Soil exchangeable cation content increased with urine application. We conclude that urine can substitute for ammonium nitrate under non-saline conditions. Over-fertilisation with urine under saline conditions may have a deleterious effect on plants while substantially increasing soil salinity and should be used with caution.

Keywords: Ammonium nitrate, electrical conductivity, fertilisation effect of urine, inorganic salts, liquid fertiliser, soil salinity, urine

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Genetic Identification of Rhizobia Isolates: Behaviour on Bean (*Phaseolus vulgaris* L.) Genotypes

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The work was carried out with the aim to identify and characterise isolates of *Rhizobium* genus from 13 sampling areas in central provinces of Cuba (Sancti Spiritus, Villa Clara and Cienfuegos), and to determine the effect of the isolates on phenotypic and growth parameters of common bean genotypes under controlled conditions. The morphological analysis was based on determining the differences of the colonies obtained from isolation, which evaluated the Gram stain, growth type, colour, slime production, edge and elevation. The genetic identification of isolates was performed by molecular tools using 16S rRNA gene sequencing. Under controlled conditions the nodulation, phenotypic parameters, biomass and nitrogen content were evaluated on ICA Pijao and BAT-304 common bean genotypes. The results showed a wide morphological diversity of native strains in the soils of central Cuba. A total of 33 isolates showed different characteristics in at least one parameter measured. A total of 22 sequences were analysed for genetic identification, turning out six genus of bacteria matching to *Arthrobacter*, *Chryseobacterium*, *Enterobacter*, *Stenotrophomonas*, *Pseudomonas* and *Rhizobium* genus. Rhizobia were the only bacteria with differences at species level. From eight sequences aligned belonging to the genus *Rhizobium*, four species (*Rhizobium* sp., *R. etli*, *R. pisi* and *R. radiobacter*) were identified including the first report of *R. pisi* for Cuban soils. Phenotypic analysis showed the beneficial effect of the species *R. etli* and *R. pisi*, respectively, increasing the growth parameters, biomass production and nitrogen content on bean genotypes. Genotypic variability demonstrated the close correlation among these strains and genotype BAT-304 compared with ICA Pijao.

Keywords: Genetic identification, growth parameters, nitrogen content, *Phaseolus vulgaris*, *Rhizobium*, strains

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Influence of Quality Compost on Plant Growth and Mycorrhizal Colonisation in Corn

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The soil functions for agricultural productivity and environmental sustainability depend on soil organic matter. At present, its degradation is a rising problem in most agricultural lands worldwide. The maintenance and improvement of organic matter is an effective mechanism to combat soil or land degradation, reversing the declining trend in agricultural productivity and preserving the environment for present and future generations. The objectives of this study were to evaluate the effects of a high quality compost application to soil on (i) total dry matter and other yield parameters of corn (*Zea mays* L.), (ii) plant nutrients uptake, and (iii) the infectivity potential of indigenous arbuscular mycorrhizal fungus (*Glomus mosseae*) of corn roots. The two tested composts were produced from biowaste alone or a mixture of biowaste and horse manure. Corn plants were grown in pots in the greenhouse, their yield structures, mycorrhizal root colonisation and soil nutrient bioavailability were determined. Overall, results indicated that compost application to soils increased plant height, leaf area index and biomass dry matter yield of corn significantly ($p < 0.001$) as compared to the control treatment. The maximum plant growth and major nutrient composition in the tissue were found in the pure biowaste treated pots. The highest indigenous mycorrhizal colonisation was recorded in the control treatment, while compost amendment negatively affected them. That might be associated with higher bioavailability of plant nutrients, particularly phosphorus in the compost treated pots than in non-treated one. Hence, it is plausible to conclude that the highest bioavailability of plant nutrients and the highest functional groups of soil organic matter are noted after quality compost addition. Such noted changes play an important role in the soil functions to improve plant productivity. A similar long-term experiment is essential for a better understanding of the changes in soil functions as well as to better follow organic matter development.

Keywords: Compost quality, corn, mycorrhiza, plant nutrients

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Influence of Fertilisation and Field History on Soil Properties and Microbial Communities and Its' Relation to *Striga hermonthica* (Del.) Benth. Population Density in the Kati District of Mali

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The parasitic plant *Striga hermonthica* (Del.) Benth. causes enormous yield losses particularly in cereal crops in the semi arid tropics, mainly in Sub-Saharan Africa and Asia where cereals provide the main resource for human nutrition. Beneath several control methods organic fertilisation and soil organic matter itself, have controlling effects on Striga. Former investigations indicated under the conditions of Ghana that the higher the organic matter content of the soil the lower is the *Striga* seed bank density and the less *Striga* emerged. The present research study investigates the relationship between field history, fertilisation, soil organic carbon, abundance of microbial community structures and *Striga* presence in the region around Sindala in Mali. Based on interviews with the farmers, selected fields with high and low organic fertilisation and different emergence of *Striga* were chosen for soil sampling and analysis. Soil was analysed for phospholipid fatty acids (PLFA), dissolved organic carbon (DOC), microbial biomass C and N and further relevant parameters like pH, texture, Ntotal, NO_3, NH_4^+, P, K, CEC, Corg and exchangeable bases Ca and K. The results are interpreted with regard to the differences in soil microbial communities, via the PLFA patterns, between high and low organic matter content, influenced by organic fertilisation, and its impact on *Striga* emergence and seed bank density. This should lead to a more detailed knowledge whether organisms and/or other factors within the organic matter or facts relating to field history are playing a significant role in controlling *Striga* under a high organic fertilisation practice.

Keywords: Control method, microbial communities, organic matter, PLFA, *Striga*

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Forests and agroforestry

Historical Paradigm Shifts in Tropical Forest Plantations

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Forest related humanistic and social scientific research is generally under-represented in the field of forestry, in spite of its deep interrelation with other disciplines. However, forest practices and policies related to the general socio-economic development are very interesting from the social sciences perspective.

While forestry and silvicultural sciences focus predominantly on the technical aspects of tree planting, it was acknowledged already decades ago, that plantation forestry has very significant socio-economic and also political impacts, perhaps especially so in the developing world.

It is therefore important to ask about the particular systems of knowledge that organise global plantation forestry, how these were changing and what are the dominant knowledge-systems influencing plantation practices today.

The paper aims at showing the change in approaches to plantation forestry, with particular emphasis on tropical regions. Introducing the concept of a "paradigm", a set of historically changing assumptions, concepts, values, and practices that constitutes a way of viewing plantations, and directs plantation related policies, it traces the development of such structures of knowledge in the history of plantation forestry. A wide historical sketch of trends and milestones in plantation forestry accompanied with analysis of World Forestry Congress documents (as the most graspable forum of what can be termed an "epistemic community" of plantation forestry), FAO archival documents and a content analysis of a sample of issues of the influential journal "Unasylva" are discussed to show the evolution of meanings and associations of forest plantations. Based on the vast textual analysis, a classification of the "paradigms" (with "paradigm shifts") is proposed and discussed in relation to the understandings and impacts of plantations.

Keywords: FAO, paradigm, plantation forestry, tropics, Unasylva, World Forestry Congress

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Adoption and Socioeconomic Evaluation of Multistrata Agroforestry Systems in Peruvian Amazon

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Slash-and-burn agriculture is considered as a main cause of deforestation in the Peruvian Amazon. Agroforestry systems (AFS) are regarded as a feasible alternative to slash-and-burn for small scale farmers. Main aims of the present study were (1) an evaluation of the adoption rate of multistrata AFS promoted by a development cooperation project among farmers in the Ucayali region including the analysis of the factors influencing the adoption and (2) the economic assessment of multistrata AFS and slash-and-burn land use systems. The study took place in nine villages of the Pucallpa zone where data have been gathered from farmers (n=59) via semi-structured questionnaires. The economic assessment was based on cost-benefit analysis: Net Present Value (NPV), Cost/Benefit Ratio (CBR) and Internal Rate of Return (IRR) indicators. Results are showing that multistrata AFS have been adopted by 78 % of the farmers participating in the project and that 47 % of the farmers managed to increase their multistrata plots. Factors positively associated with multistrata AFS adoption are higher formal education, previous experience with perennial plants, plot distance and organisation membership. Major constraints to further adoption of the systems are accidental fires and unavailability of quality germplasm. Major implications are that future development and promotion of agroforestry systems should address these issues. Economic analysis gives clear evidence that multistrata AFS are more profitable than slash-and-burn agriculture, with NPV three times higher on the average. On the other hand, slash-and-burn plots have higher IRR. Major drawbacks of multistrata AFS economic performance in comparison to slash-and-burn agriculture are higher establishment costs and longer time needed to reach the breakpoint of positive net present value.

Keywords: Adoption, Amazon, land use systems, net present value, slash-and-burn, small farmers

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Sustainable Intensification with Best Management Practices for Oil Palm in Marginal Environments of Southeast Asia

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The national average palm oil yields achieved in Indonesia continue to fall well below potential levels, and yields have stagnated for the last two decades as total production increased in line with planted area. However, at the level of a large company managing a group of plantations (ca. 150,000 ha), average oil yield of 6 t ha^{-1} and fresh fruit bunch (FFB) yield exceeding 27 t ha^{-1} have been reported. How can the rest of the industry reduce the yields gaps? The gap between actual achieved yield and the maximum yield potential can be apportioned into 3 parts: Yield Gap 1 arises from inefficiencies during development of a plantation until the end of the immature period; Yield Gap 2 arises from inaccurate assessment of nutrient requirements; and Yield Gap 3 arises from inefficiencies in the management of the mature stand. There are limited opportunities for plantations to correct Yield Gap 1. Yield Gaps 2 and 3 can be corrected in existing mature stands. Yield gap analysis can guide the implementation of best management practices (BMPs) for intensifying yield. IPNI Southeast Asia (SEA) has executed the BMPs as a management tool for yield intensification in mature plantations. A set of site-specific BMPs are identified and implemented in a number of full-sized management blocks representative of a plantation. The concept has been successfully implemented at 6 sites since 2006 in major production areas of Indonesia. IPNI SEA reported preliminary results from a limited number of years elsewhere. In this presentation, we will document the complete set of results from the BMP programme of IPNI SEA for the sites including those in marginal environments, demonstrating the usefulness and success of BMP over 4 years. The paper presents an overview of achievements regarding fresh fruit bunch and oil yields, the performance of the various yield components, and illustrates yield trends over the implementation period. The paper will discuss strategic implementation aspects covering (a) cost-benefit analyses as a tool for systematic decision support guiding the BMP implementation process, (b) resource constraints and management options, and (c) the further integration into whole plantation management.

Keywords: Best management practices, BMP, Indonesia, marginal environments, oil palm, sustainable intensification

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Suitability of Tree Species for Afforestation of Marginalised and Abandoned Croplands in Uzbekistan

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Marginalisation of irrigated croplands due to salinity, resulting in abandonment of degraded parcels, negatively impacts agricultural production and peoples' livelihood. This study focused on the afforestation of abandoned croplands, as an (irrigation) water saving alternative land use in the lower reaches of the Amu Darya River, Uzbekistan. To this end, the survival and early growth of six tree species considered for non-timber production and carbon sequestration were field-tested on two deserted cropping sites. To identify areas which can be potentially targeted by afforestation, spatial delineation of degraded croplands was implemented based on time series analysis of normalised difference vegetation index (NDVI) images from the Moderate Resolution Imaging Spectroradiometer (MODIS).

Both study sites were characterised by the presence of salts in soil (10–12 dS m^{-1}) and groundwater (2–5 dS m^{-1}), and deficiency in soil nutrients. The sites differed in depth to the groundwater table (GWT), which fluctuated between 0.4 and 0.9 m and 0.6 and 1.8 m from the soil surface. Tree establishment was assessed at the end of the first growing season in September 2010. Under deficit irrigation of about 150mm, five of six tested species showed survival rates ranging from 65 to 99 %. Thus, shallow, moderately saline groundwater satisfied the initial tree water demand. Moreover, the deeper GWT was not associated with a lower tree survival, indicating that afforestation could be potentially expanded to such areas.

Ulmus pumila performed best among the species, demonstrating survival rates of $>$98 % and $>$92 % and above-ground biomass increment of 70.4 and 172.0 kg ha^{-1} $year^{-1}$ in the presence of the shallow and the deeper GWT, respectively. *Populus euphratica* failed to establish, underlining its limited suitability.

The spatial assessment showed that 85,213 ha of the study area experienced a lowered NDVI for 2001–2009, indicating land degradation trends. This area defines a potential scope for afforestation intervention in the region and will be analysed for its suitability for tree planting.

The feasibility of tree plantation establishment on marginalised croplands that can be detected with the remote sensing technique lays a promising ground for remediation of land degradation in the region.

Keywords: NDVI, plantation forestry, salinity, shallow groundwater table, spatial land assessment

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Microclimatic Changes in Different Alley-cropping Width and their Impact on Growth and Yield of Wheat in the Dry Zone of Central Sudan

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Wheat is the second most important cereal crop in the Sudan. To meet its ever-increasing demand, its cultivation spreads southwards into the central plain of Sudan, where there is plenty of land and water available. However, the highly stressed environment of the central Sudan is impeding wheat production. Thus, producing wheat in an alley cropping system poses a challenge to agroforestry research. Field experiments were conducted during 2008–2010, at the Agroforestry Research Farm of the Gezira Research Station in the dry zone of central Sudan (latitude 13.5 - 15 N and 32.5 - 33.6 E). The objective of the study was to examine the effect of alley-cropping microclimate on wheat production. Experimental design was a split-split plot. Main plots were tree species (*Acacia ampliceps* and *Acacia stenophylla*), the sub-plots were alley width: 6, 8, 10, 12, 16 and 20 m and the sub-sub plot were assigned for wheat (*Triticum aestivum*, variety Imam). Aboveground interactions were examined by installing a series of weather stations in different zones of the different alley width and control plots. Solar energy at ground was measured using tube solarimeters.

Results showed that, in alley cropping plots, there were significant ($p < 0.01$) reductions in wind speed, solar radiation, air temperatures and high increases in relative humidity. With regard to these parameters *A. ampliceps* had better results than *A. stenophylla*. On spacing basis, the narrow spacing (6–10 m) had a higher increase in relative humidity (7 - 10 %) and higher reduction in maximum temperature (1.3–2.6°C). The grain yield and yield components (no. spikes, seed weight per head, and 1000-seed weight) had higher values in the narrow alley width (6 - 10 m width). Increase in grain yield in the different alley widths ranged between 33 and 67 % and between 33 and 59 % in *A. ampliceps* and *A. stenophylla*, respectively. In the two consecutive seasons, the 8 m alley – with optimum radiation – had the highest increase in grain yield of 67 % (1616 kg ha^{-1}) and 59 % (1545 kg ha^{-1}) for *A. ampliceps* and *A. stenophylla*, respectively. The lowest yield was obtained in the 20 m alley, which had a similar increase in grain yield (33 %) for both tree species.

Keywords: Alley widths, dry zone, microclimate, solar energy

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Aboveground Net Primary Production Response to Chronic Nitrogen Addition in a Tropical Montane Forest

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Nitrogen (N) deposition in tropical areas is projected to increase rapidly in the next decades and little is known on how tropical forest productivity will respond to increase in N availability. We used an N-addition experiment to achieve an N-enriched condition in an old-growth forest growing in an Aluandic Andosol soil at 1200–1300 m elevation in Fortuna Forest Reserve, Panama. Control and N-addition treatments (starting in 2006 at a rate of 125 kg urea-N ha^{-1} yr^{-1}, split in four applications) were laid out in paired-plots design with four replicate plots (40 m $\times$ 40 m each, separated by $\geq$40 m distance). Here, we report the changes in various components of above-ground net primary production (ANPP) during the 3–4 yr N addition: stem diameter growth (separated by diameter at breast height (DBH) classes of 10–30 cm, 30–50 cm, and $>$50 cm), woody biomass production (WBP) and fine litterfall. No significant differences were observed between 3–4 yr N addition and the control in stem diameter growth of any DBH classes or all classes combined (control: 1.6$\pm$0.2 mm yr^{-1}; N-addition plots: 1.9$\pm$0.2 mm yr^{-1}), in WBP (control: 4.3$\pm$0.6 Mg ha^{-1} yr^{-1}; N-addition plots: 4.2$\pm$0.5 Mg ha^{-1} yr^{-1}), in total fine litterfall (control: 7.3$\pm$0.4 Mg ha^{-1} yr^{-1}; N-fertilised: 8.0$\pm$0.4 Mg ha^{-1} yr^{-1}), and in ANPP (control: 11.6$\pm$0.8 Mg ha^{-1} yr^{-1}; N-fertilised: 12.3$\pm$0.8 Mg ha^{-1} yr^{-1}). The first 2 years of N addition showed significant increase in ANPP compared to the control, and this was mainly due to increased leaf-litter production. Our results showed interannual variation of ANPP response to N addition.

Keywords: Aboveground net primary production, chronic nitrogen addition, tropical forest

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Allometric Relationships of Frequently used Shade Tree Species in Cacao Agroforestry Systems in Sulawesi, Indonesia

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Agroforestry systems carry great importance in the conservation of the tropical rainforests, particularly of the rainforest margins as they reduce the pressure on natural forests. Shade trees play an important role within the agroforestry systems by influencing radiation and wind regimes as well as nutrient and hydrological cycling. However, there is a lack of quantitative assessments of their functions. One of the reasons is the rare information on structural characteristics of shade tree species. Therefore, the aim of this study is to provide basic information on the structure of frequently used shade tree species for the implementation of models simulating the ecosystem processes in agroforestry systems. The investigation of the shade trees was conducted at two cacao agroforestry sites on Sulawesi, Indonesia. The measurements of the main structural parameters: diameter at breast height, tree height, trunk height, crown length and crown radius were carried out for the shade tree species *Aleurites moluccana*, *Cocos nucifera* and *Gliricidia sepium*. For data collection the National Forest Inventory Field Manual Template by FOA (2004) was applied whereas the height measurements were conducted with a Vertex IV ultrasonic hypsometer performing the trigonometric principle. Based on this information the allometric functions were derived for the correspondent shade tree species. The best significant relationships were obtained for the height-crown length relationship of the dicotyledonous tree species' *Aleurites moluccana* and *Gliricidia sepium* with a coefficient of determination r^2 = 0.925 and r^2 = 0.738, respectively and the height-trunk height relationship of the monocotyledonous palm *Cocos nucifera* with r^2 = 0.807. The transferability of the obtained allometric functions was examined using the results of the measurements performed in other sites in the region. Further research should be implemented to extend the knowledge on agroforestry systems by obtaining information on the same tree species from other regions and by measuring structural properties of other main shade tree species.

Keywords: Agroforestry system, allometric relationships, shade trees, tree architecture

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Structure and Regeneration of Degraded Forest in Tam Dao National Park, Vietnam

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The lowland tropical forest in Tam Dao National Park was degraded by human activities such as selective logging, clear-cutting, shifting cultivation, and so on. It had lost its structure, function, species composition and turned into degraded forest. The degraded forest (latitude 21º28'31.3", longitude 105º35'24.3") in the study area has been protected since 1996 and rehabilitated by natural regeneration. A total of 125 species representing 90 genera and 47 families were found in this forest. The basal area of forest is approximately 15 $m^2\,ha^{-1}$, it is more than two times smaller than the basal area of the mature forest (38 $m^2\,ha^{-1}$). Species richness of mature trees with diameter at breast height (DBH) > 10 cm is with 88 species of average. Besides that, the present structure of forest has only 3 layers: top-layer, under-storey and regeneration. The pre-dominant layer with tree DBH > 50 cm has been destroyed. The top-layer with trees 15–20 m in height and greater than 40 cm in DBH (such as *Mesua ferrea*, *Choerospondias axillaries*, *Styrax tonkinensis*, and *Canarium tonkinense*) is very rare. In contrast, the under-storey has a high density of trees around 8–10 m. The regeneration layer includes shrubs, seedlings and saplings of trees. The seedling and sapling density is about 9,200 stems ha^{-1} and 8,300 stems ha^{-1}, respectively. In general view, the process of natural regeneration in the degraded forest is quite good but some species with an important value index are absent, for instance: *Choerospondias axillaries*, *Symplocos laurina*, *Engelhardta chrysolepsis*, and *Sapium discolour*. In brief, even though this forest has been well protected it still has a poor structure and a low biodiversity because of the strong human disturbances in the past. Moreover, some valuable species are not present at the regeneration layer. Therefore, further research is necessary to stimulate regeneration of highly valuable species.

Keywords: Degraded forest, forest structure, human disturbances, natural regeneration

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Natural Regeneration Patterns Beneath Canopy of Old-growth Tropical Moist Evergreen Forests in Vietnam

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A comparative study of regeneration patterns beneath the forest canopy of old-growth tropical rain forests was conducted in three national parks in varying ecological zones of Vietnam. The main objectives of the study were (1) to describe and compare regeneration patterns within and between different forests and (2) to assess the relationship between some structural factors and abundances of seedlings and saplings. Within one study site, 25 sample plots of 400 m^2 were set up systematically to measure all canopy trees. One 25 m^2 subplot and two 4 m^2 subplots were set up at the centre of each plot to measure all saplings and seedlings, respectively. The study showed significant variation in species and family compositions. Of the 134 sapling and 94 seedling species recorded, only 12.4 % and 12.8 % species, respectively, were re-found between two forests. 6 out of 37 seedling families and 11 out of 46 sapling families were identified in all three national parks. The diversity indices were found to be least under the canopy of Cucphuong forest, followed by Pumat and Xuanson forests while all diversity indices revealed from sapling storey were similar to higher compared to those revealed from seedling storeys. Generally, seedling and sapling abundances and sapling height were not significantly different between the three studied stands while seedling height and root collar diameter of seedlings and saplings showed statistical difference. The Sorensen's index of similarity indicated a considerable similarity between canopy and sapling storeys in Xuanson and Pumat forests (61–70 %). He was higher than the similarity between canopy and seedling storeys (53–58 %). Abundances of seedlings were strongly influenced by the height of canopy trees, shrub cover (Xuanson), shrub height (Cucphuong), canopy area and tree density (Pumat) whereas only the leaf area index of canopy trees in Pumat forest showed its influence to sapling density. In conclusion, the variation of regeneration patterns in our studied areas suggests that none of the studied plots can be considered as a representative sample of the tropical rain forest in the entire region and any results revealed from a specific plot along tropical rain forest should be considered accordingly.

Keywords: Natural regeneration, species composition, species diversity, tropical moist evergreen forests

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Population Structure and Natural Regeneration of *Boswellia papyrifera* Hochst. in Dry Woodlands of Nuba Mountains, South Kordofan State, Sudan

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Boswellia papyrifera (Del.) Hochst. family *Burseraceae* is an important indigenous multipurpose tree species known for its diverse ecological and economic benefits. In economic terms frankincense or gum olibanum is its most valuable product which has a broad spectrum of applications in cultural uses and modern industries. Despite the potential and actual economic development and environmental conservation benefits of the species, its population and habitat is degrading. Adequate knowledge on the current status of its population is crucial for a sustainable management. The objectives of this study were (i) to analyse the population structure and density of *B. papyrifera*; (ii) to analyse the natural regeneration status of *B. papyrifera*, and (iii) to assess the impact of frankincense harvesting. The study was carried out in two woodlands in South Kordofan state, Sudan in 2008: Kajinat forest (preserved) and Tajmala forest. Random sampling was used for selection of sample plots of $20\,\mathrm{m} \times 20\,\mathrm{m}$ size in Tajmala (12 sample plots) and Kajinat (21 sample plots) forests. Smaller sample plots of $5\,\mathrm{m} \times 5\,\mathrm{m}$ size were nested in the centre of each plot for regeneration assessment. The results reveal that the population of *B. papyrifera* is unstable and occurs with low densities 81 ± 79 trees ha^{-1} and 52 ± 50 trees ha^{-1} in the preserved and not-preserved forest, respectively. The population structure in both stands looks inverted 'J' shaped depicting the low regeneration and recruitment of the species. In addition, all individuals encountered in the sample plots in both stands have diameter at breast height (DBH) greater than 11 cm indicating the lack of juvenile individuals and lack of recruitment. The results illustrate that there is a complete lack of regeneration and juvenile individuals in combination with high mortality, damages by insect and browsing. Moreover, 43 % of all individuals were observed severely over tapped at more than 15 tapping spots. We conclude that *B. papyrifera* stands are under threat and frankincense production is being done without a sustainable management plan and supervision. Proper management plan and domestication of the species through artificial regeneration and conservation through area closure are urgently needed.

Keywords: *Boswellia papyrifera*, density, dry woodlands, natural regeneration, population structure, tapping of frankincense

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Assessment of Post-fire Forest Structural Diversity Using Neighbourhood Based Parameters in the Sierra Madre Oriental, Mexico

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In order to determine the effect of fires on forest structural diversity the goal of this research was to characterise the post-fire spatial structural patterns in a *Pinus hartwegii* forest in the Sierra Madre Oriental, Mexico, affected by the 1998 forest fire. We defined three fire severity classes based on the degree of consumption of the pine canopy (low, medium, and high). Three samplings plots of $40\,\mathrm{m} \times 40\,\mathrm{m}$ were established on each fire severity. The variables obtained for all trees with diameter at breast hight (DBH) $\geq 5\,\mathrm{cm}$ at each plot were: DBH in cm (1.30 m), total height (m), spatial location by azimuth and distance (m) from plot centre to each tree. To describe the stand structure three groups of indices were employed: "contagion" and "distances" (Wi and Di), "dominance" (Ui) and "size differentiation" (TDi and THi). An ANOVA was performed to detect differences between dasometric parameters by severity. For the statistical analysis the R-statical Software was used. The neighbourhood-parameters were conducted using the Winkelmass program. Statistical analysis show significant differences in the dasometrics parameters (basal area, diameter and height) between the low, medium and high severities. The average values of Wi for the three fire severity classes (0.528, 0.550 and 0.594, respectively) confirm a tendency to aggregate. Mean values of distance (Di) between trees was 6.49 m, 5.63 m and 6.33 m for low, medium and high severity, respectively. The mean dominance values with respect to the diameter and height (Ui) for low, medium and high severity were 0.504, 0.483 and 0.475 and 0.500, 0.491 and 0.453, respectively. The average values of the differentiation in diameter and height were TDi= 0.17, 0.28, 0.33 and THi= 0.11, 0.18, 0.27, respectively. The results show that with increasing fire severity increases the degree of clustering as well as the differentiation in diameter and height. On the other hand, the dominance of size decreases with increasing severity. Continuing research on forest structure in forests of the Sierra Madre Oriental, including not only neighbourhood-parameters but also point pattern analysis, is needed in order to have a higher accuracy in spatial modelling.

Keywords: Forest structure, *Pinus hartwegii*, Sierra Madre Oriental

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Characterising Spatial Structure of Natural Mixed Forests in Mexico

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Stand structure is related to the spatial and temporal arrangement of individual trees in a forest stand. The spatial structure defines the organisation of the trees in space while temporal structure refers to successional patterns over time. The study presents a characterisation of spatial process and intertype analysis of tree locations in natural forests of greater diversity and of high ecological significance in Durango, Mexico. These forests, with rare conifers including the species: *Picea chihuahuana*, *Abies durangensis* and *Pseudotsuga menziesii*, are found on particular sheltered, humid sites. Two different spatial statistics, know as nearest neighbour analysis F(r) and Ripley's K(r) function have been used for analysing the tree-mapped data. Patterns and spatial interactions for trees in different species, sizes, and dominance classes were analysed separately. The results show that both methods are complementary and give a detailed description about the types and scales of the observed tree patterns. However, Ripley's K(r) analysis better revealed different aspects of the spatial process for the analysed classes of trees within the plots when compared to the nearest neighbour statistic and is a powerful tool for analysing the spatial relationships between different classes of trees. The examples presented here indicate: a significant dependence or attraction between species. Trees in the smallest class significantly avoid trees in the tallest height class, and there is a positive association between suppressed trees and co/dominant and dominant trees, reflecting the presence of self-thinning within the plots. Positive spatial associations (aggregation) in this forest seem to be highly linked with seed dissemination processes, the relative shade tolerance of some species, and specific preferences for soil patches. On the other hand, repulsive interactions (spatial regularity) could be an indication of competition processes that imposes a minimum distance between trees.

Keywords: Nearest neighbour analysis, Ripley's K(r) analysis, spatial tree distribution

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Lack of Regeneration and Sustainability Crisis of Northern Zagros Forests of Iran

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Northern Zagros forests have the highest diversity of oak species of Iran. Underdevelopment, lack of arable lands due to the mountainous situation, and shortage of ranges led to high dependence of local inhabitants on forest resources. Grazing by domestic animals, for more than 7 months, leads to the destruction of ground vegetation and soil compaction. Most of the seedlings grazed or dried out during the summer, so forest structure and finally forest sustainability are suffering. To understand how forest structure might be affected, diameter distribution curve, as a guideline for forest structure was considered. We carried out a random-systematic sampling within 4000 ha forestland in Armardeh. In 87 circular sample plots, dbh was measured for all trees ($\geq$5 cm dbh) and regeneration was measured in micro plots. To determine diameter increment, several cross sections were taken from trees. Results showed that the diameter distribution pattern was almost bell-shaped and skewed to the right. This means that Armardeh forest has an even aged structure comprised of few young trees and a large number of old trees. Average annual diameter increment was counted 2 mm for cross sections. In most of the discs about one third to one half of their width was hollow. A simple simulation based on diameter increment, was done with Microsoft excel. The output was several diameter distribution curves dispersed in a time sequence of 70 years. They showed that the diameter distribution curve will move to the right hand with time laps, the number of young trees will reduce and old trees will increase. So, in 2075 (after 70 years) the diameter distribution curve might have a narrow range from 21.5 to 61.5 cm while this was 7.5 to 62.5 for 2005. We discuss that sustainability of Armardeh forest is facing a serious problem. Every year some trees might be broken by wind and snow. Considering our results, low input (lack of regeneration) and high mortality are two most important features of unbalanced forest structure. The most essential attempt is to investigate the methods to establish and guarantee regeneration in the Armardeh and similar forests.

Keywords: Diameter distribution curve, oak, regeneration, sustainability crisis, Zagros

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Forest Management Practices in Central Highlands of Vietnam: Case Studies in two State Forestry Companies

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State forestry companies (SFCs) are the main owners that manage production forests in Vietnam. During the early 1990s of the Doi moi (market-oriented reform policy) era, SFCs have played an important role in the forestry sector and impacted the livelihood of millions of people living in those managed areas. However, being mainly based on natural forest harvesting, the forests under management of SFCs have been declining in term of both area and quality. Unsustainable forest management is supposed to be a major problem. To date, no natural forest management in Vietnam is recognised to follow sustainable forest management (SFM) principles despite there are now reform policies and SFM approach in tropics.

The investigation focuses on reviewing, understanding and evaluating the conventional forest management practices in SFCs based on a Strengths-Weaknesses-Opportunities-Threats (SWOT) analysis of forest management. In the study, two SFCs in Central Highlands of Vietnam are examined. The research objectives are to identify interventions for promotion of SFM after revealing the disadvantages under conventional forest management practices in SFCs. Special aspects suppose to be examined the weak forest management competency of the owners, the continuous existence of semi-autonomous entities, the lack of environmental awareness, and land-use conflicts with local communities.

As expected, the reforms have to focus on the integration of adaptive management concepts of sustainable yield regulation, introduction of reduced impact logging, participatory forestry, multi-scale planning, biodiversity conservation. Moreover, market-based instruments for incentives coming through payment for environmental services (PES), benefit from forest certification (FC), and payment in exchange for reduced emissions from deforestation and forest degradation (REDD) should be applied. Consequently, the SFCs have to be fully reformed in order to become independent business SFCs including the autonomy of plan, finance and human resources.

The respective promotion steps will be elaborated and connected in an advanced SFM model.

Keywords: Central highlands, model, production forest, state forestry companies, sustainable forest management, tropical forest, Vietnam

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Acacia mangium and *Eucalyptus urophylla* in Northern Vietnam: Relationship between Silvicultural Activity and Quality of Stand

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The Vietnamese government is currently carrying out a large scale "reforestation" programme (Five Million Hectare Reforestation Program). Smallholders plant a wide range of tree species where a large part of the planting taking place in Vietnam today concentrates on fast growing trees, aimed at producing raw material for the pulp and paper industry or woodchips. Nearly eight million people living in or near forest lands spend much of their time for their livelihood security. Poverty is fundamental problem in Vietnam, with 90 percent of the poor living in rural areas and with incidence of poverty being much higher in rural areas than in urban ones. Poverty in Vietnam will be mainly rural for the foreseeable future. For this reason, short- to medium-term poverty alleviation efforts will have to be heavily focused on forest resources and silviculture. In Phu Tho province, the most common fast growing exotic species planted are *Eucalyptus urophylla* and *Acacia mangium*. This paper sets out to determine the link between socio-economic characteristics of smallholders, silvicultural activity and the stand quality of *Acacia mangium* and *Eucalyptus urophylla* plantations in two independent case study communes in Phu Tho Province, Vietnam. Data was collected by interviewing the smallholders and conducting inventory of the stands and analysed with descriptive statistics, Mann-Whitney tests and Spearman correlations. *Acacia mangium* planters with larger areas carried out more silvicultural practices. Most of the farmers carried out the suggested silvicultural practices. Pruning had an effect on productivity in medium quality sites. As the improvement of stand quality is very important, more research is needed to analyse scheduled time, frequency and suitable methods for silviculture. This research recommends that smallholders be supported with (a) incentives for the plantation establishment, (b) education for smallholders in silvicultural techniques, (c) organisation and development activities for the wider market.

Keywords: *Acacia mangium*, *Eucalyptus urophylla*, Northern Vietnam, silvicultural activity, stand quality

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Four-dimensional Agriculture: Successional Agroforestry for Ecological and Socio-economic Resilience Building

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Successional agroforestry systems have proved to recover soil fertility and to enhance adaptation to difficult climate conditions in highly vulnerable tropical regions. This study introduces the principles of successional agroforestry and reviews surveys and ongoing research. In the humid tropics, annual cultures in slash-and-burn cultivation are one of the main reasons for deforestation and soil degradation. Annual crops in association with permanent cultures such as cocoa, coffee, fruit and timber trees are more resilient to stress factors such as heavy rains or droughts than mono-cultures. Successional agroforestry is characterised by a diversity of crops (horizontal and vertical), trees, shrubs and other naturally regenerating species of the local ecosystem taking into account the dynamic of successional processes and making use of all storeys occupying as much ecological niches as possible, similar to the natural vegetation (spatial and temporal). The combination of a high plant density and diversity provides a wide range of ecosystem services and self regulation processes. An important management aspect is pruning of the accompanying species and those who completed their production or life cycle. The pruned branches and leaves cover the soil protecting it from intense solar radiation, erosion due to heavy rainfalls and increase soil organic matter and metabolic rate of energy as well as the availability of organically bonded water. Recent research from Bolivia indicates less abundance of fruit flies (*Anastrepha* spp. and *Ceratitis captitata*) in orange production in successional agroforestry with significantly higher yields and the same sugar content, significantly more humus in soils and a deeper Ah-horizon than in comparable monocultures. A study on economic viability showed that successional agroforestry competes with monocultures with regard to the area equivalent of the respective crops, whereas the high diversity of crops decelerate economic risks and diversifies the diets of local small scale farmers. In the region Alto Beni, a long-term field trial was established in 2008 to compare organic and conventional cocoa cultivation which also includes successional agroforestry with cocoa as a primary forests' species. This is combined with on-farm research to link the biophysical research questions with farmers' perceptions and needs to implement this practice.

Keywords: Biodiversity, cocoa, organic agriculture, resilience, soil fertility

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Multipurpose Tree Species Used by Small Farmers in the Region Ucayali, Peruvian Amazon

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Trees provide a range of significant products and services to rural and urban people. An alternative to the traditional slash-and-burn agriculture, which plays a crucial role in deforestation of the Peruvian Amazon, is known as agroforestry, a sustainable land use system. Before carrying out extensive agroforestry programs, it can be necessary to make an assessment of preferred and useful multipurpose tree species. This step is essential for further research such as revealing of species genetic improvement potential, leading to more efficient utilisation of genetic resources. Primary objectives of this study were to assess tree species preferred by small farmers and compare results with a previous study of Villachica (1995) to see if preferences around Pucallpa city have changed. The methodology was based on the process developed by ICRAF and ISNAR with modifications to the study conditions. In total, 64 farmers were surveyed by semi-structural interviews within four areas of Ucayali region. They listed 77 local species names. Among top ranking native ones were: *Swietenia macrophylla*, *Inga edulis*, *Theobroma cacao*, *Cedrela odorata*, *Guazuma crinita*, *Calycophyllum spruceanum*, *Mauritia flexuosa* and *Croton draconoides*. From the results, it is possible to observe that preferences among farmers have changed quite significantly over the last 15 years. Respondents mentioned only 15 introduced species which proves an important role of native trees within the region. According to the increase in fruit species' preferences, it seems that our efforts should aim at the domestication and improvement of native fruit trees, as probably the most promising option for the small farmers.

Keywords: Agroforestry, preferences assessment, priority trees, species improvement, sustainable development

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Assessing the Impact of Forest Management Certification – Options for Research

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International trade in forest products is affected by environmental and social concerns. Growing environmental awareness and consumer demand for more responsible businesses helped third-party forest management certification emerge in the 1990s as a tool for assessing and communicating the environmental and social performance of forest operations. The Forest Stewardship Council (FSC) is an international non-profit membership-based organisation which develops standards for responsibly managed forests. FSC's nationally adapted standards are widely accepted among a broad cross-section of stakeholders as being consistent with the principles of good forest stewardship. The FSC logo is a powerful incentive for forest managers and decision maker to improve their forest management continuously: As of April 2011, FSC has certified more than 1.000 forest management companies in more than 80 countries.
In conducting forest audits, FSC-accredited certification companies do not certify that a forest management unit has 'achieved sustainability', nor do they require or imply the implementation of uniform sets of forest management prescriptions: they certify that FSC requirements for forest management have been met. Over the years different authors and research networks analysed public certification reports and reviewed literature about certification impacts, and found that certification has the potential to and actually has for example - helped to secure or improve environmental services in certified forests; - improved workers' conditions within certified forests; - acted to reduce social conflict in and around certified forests; - helped in securing land tenure of certified community forests; - improved the image of the forest management enterprise; - provided better access to premium timber markets (where they exist); and - helped to promote sustainable forest management more generally through dialogue between the private sector, government bodies, non-governmental organisations and civil society.
The poster shows where an update of the evaluation of impact is needed, and where individual researchers and research institutions can provide assistance to improve the strength of compliance with FSC's Principles and Criteria, so that the certification of sustainable forest management in a changing world meets the growing demands for transparency and accountability of the many forestry stakeholders.

Keywords: Certification, forest management, impact, research needs

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Does Organic Cocoa Certification Contribute to Socioeconomic Development and Environmental Conservation in Brazil and Peru?

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Small-scale producers are responsible for over two thirds of total global cocoa production and most of it occurs in areas of high biodiversity. In Latin America, 5–6 million farmers are involved in cocoa production (Somarriba 2006; World Cocoa Foundation 2010), in an area of 8 million hectares (COPAL 2009). 15,000 cocoa farms, being the majority family farms, are currently located in the Brazilian Amazon, location of origin of the cocoa species. The organic cocoa market represents less than 0.5 % of total production, yet the production of certified organic cocoa has reached 15,500 tonnes (ICCO 2011). Latin America has had annual growth rates of volume and economic value of organic cocoa production of over 70 % in the last 15 years. Considering the increasing relevance of cocoa production in the Amazon region, and the combination of income generation and labour allocation – having generated 18.800 US$/family and 40.000 jobs in the state of Pará, Brazil, in 2010 (Mendes 2011) – as well as ecological features of cocoa farms, the main research question is whether and under which conditions organic cocoa certification may contribute to enhancing smallholders' well-being and environmental conservation. This paper presents findings of an ongoing research project led by the World Agroforestry Centre (ICRAF), by conducting a cost-benefit analysis of organic certification based on the results of survey questionnaires applied to cocoa farmers, while exploring smallholders' perceptions concerning the opportunities and limitations of organic cocoa certification based on qualitative assessments of environmental, socio-cultural and economic dimensions. The methodology was applied in Peru and Brazil enabling the comparison of two case studies, both in the Amazon, one in Juanjui, San Martin (Peru) and the other in the Transamazon Highway region, Pará (Brazil). In the latter, preliminary results indicate that only 1.5 % of the producers are currently participating in certification systems, which are not creating additional jobs, yet having a positive to very positive effect, in both study areas, on local working conditions and biodiversity, conservation of soil and water. Further adaptation of certification schemes to local conditions are to be explored in both countries.

Keywords: Amazon, cocoa, certification, smallholders, sustainable development

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Determinants of Rural Community Willingness to Participate in Forest Restoration Project in Ghana

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The dry semi-deciduous forest zone is one of the most fragile ecosystems in Ghana. This forest zone serves as buffer between the savannah in the north and the moist semideciduous forest zone in the south as well as protects the watersheds of the major rivers. By virtue of its location, the area is subjected to periodic bush fires and other anthropogenic disturbances leading to vegetation conversion and weed invasion. Natural regeneration is inhibited due to invasion of obnoxious weeds such as *Imperata cylindrica*, *Chromolaena odorata* and *Pennisetum purpureum*. Thus, to restore the integratity of this ecosystems requires contentious restoration efforts through tree plantations to catalyze natural regeneration. However, the need to involve the local community in this regard is very paramount. This study utilises market based approach to understand major determinants of individual household willingness to engage in tree plantation as means to restore degraded unproductive land in their community. Data from 222 households in the rural community of Akrobi in Wenchi District, Brong Ahafo Region of Ghana were analysed to determine factors influence individual willingness to participate in restoration activities. A modified version of Bishop and Heberlein logistic regression model was employed to analyse the rural community behaviour in relation to restoration of degraded semi-deciduous forests in their locality. Socioeconomic variables such as tenure, family size, land size, age of household head, income and level of education significantly influence their willingness to engage in mass tree plantation exercise. These variables behaved as hypothesised in the logistic model. The results have serious policy implications on implementation of restoration projects; which is an integral component of REDD initiatives. However, with appropriate incentive mechanisms in place, people are willing to go into tree plantation, particularly on less productive lands.

Keywords: Degraded ecosystem, restoration, tree plantation, willingness to accept

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Assessing Multifunctional Agroforestry Systems Applying the Resilience / Vulnerability and Adaptability (RVA) Approach

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In recent years the paradigm of sustainability has changed its notions of stability and constant behaviour for disruption and change. Thus, several approaches have attempted to operationalize these insights, with the purpose firstly to understand the systems' patterns of change, and then to readdress them towards sustainable pathways. Purposefully we propose the resilience/vulnerability and adaptability (RVA) approach, to assist the assessment of social-ecological systems by stressing on the dynamic interaction of its resilience and vulnerability, and overall adaptability, after/during the occurrence of a disturbing event/process in terms of its composition, structure and function.

Under this approach, we have assessed the multifunctional performance of agroforestry systems in the Brazilian Amazon. Methodologically, we have used the adaptive cycle metaphor to identify relevant loops of decision and change, later applied successively (participatory) multicriteria and sensitivity analyses (Vester® sensitivity analysis) to determine the more sensitive ecological, productive and administrative variables; identified types of roles (critical, buffering, active and reactive) that they perform; and finally draw decisions that ought to impel the sustainability of the system.

The results show that farmers' decisions have concomitantly fit with occurring changes. Three main successive adaptive cycles (panarchy) were identified along 60 years of land-use: a) slash-and-burn /cacao plantation was succeeded by market-oriented horticulture; b) local markets failure and the historical conjuncture (IIWW) triggered the introduction and extensive cultivation of black pepper; and c) *Fusarium* infestation of pepper plants promoted the development of diverse and multipurpose agroforestry systems. From the 31 identified variables, none is critical (capable to bring the system out of control) and the majority -ecological and productive- are buffering. Only four variables – administrative – appear to be active (able to influence on other variables), but reactive variables (able to be influenced) are absent. This suggests a system highly resilient and little vulnerable, but at the same time not very maneuverable. Hence an adaptive management should care most on retaining the ecological and productive functions stable through minimum actions.

Keywords: Adaptability, agroforestry systems, amazon, multi-criteria analysis, resilience, sensitivity analysis, vulnerability

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The Role of Tree Planting in Poverty Alleviation of Northern Ghana: A Case Study in Yinyulanyiri

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Afforestation which is the establishment of forest by the planting of trees or by natural succession is a laudable idea with enormous benefits especially in arid areas like northern Ghana. The goals of afforestation programmes can generally be grouped into economic, social and environmental, but most often the economic benefits supersede the rest. It is expected that forest plantations will play an increased role as a sustainable, environmentally and socially friendly source of world fuelwood, non-wood forest products and other social and environmental values. The German International Cooperation (GIZ) and the University for Development Studies (UDS), Tamale in cooperation with the Chiefs and people of Yinyulayiri near Nalerigu in the East Mamprusi district of the Northern region have established a community plantation on degraded land. Community involvement was key to this project since the Yinyulayiri community was very much interested in planting trees and therefore provided the land and labour for the project. It is understood that the resulting forest will be community owned with GIZ and UDS playing an advisory role of educating the community on sustainable use of the resources resulting from the forest. As a perspective it is envisaged that tree cover is provided on the degraded lands to help rejuvenate the soil but most importantly to provide fuelwood for the local population which by extension plays a vital role in poverty alleviation. The objective of this ongoing resource survey is to ascertain the extent of degraded lands that have been forested and the survival rate of the forested areas. A digital mapping of the forested area was carried out using a GPS. A tree inventory was also carried out using the random sampling method to reveal basic stand information. A 90 % survival rate was recorded. Based on this, replanting will be carried out and silvicultural management recommendations will be elaborated.

Keywords: Afforestation, degraded lands, fuelwood, Ghana

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Do Smallholders Gain from Contract with an Oil Palm Company? Lessons Learned from Jambi, Indonesia

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The rapid development of oil palm area in Indonesia particularly under contractual arrangement has led to concern over the impact on socioeconomic benefits of the surrounded communities. This paper aims to increase our understanding of the impact of specific contractual arrangements in the oil palm sector on smallholders well being. It also explores the equity effect of the contracts for different groups of smallholders. A propensity score matching and treatment effect model are employed to deal with selection problems and endogeneity that may arise in this study. Data were collected from 245 smallholders consisting of 126 contract and 119 non-contract smallholders in three villages in one district in the Province of Jambi. We find that contract participation is attributed significantly by the age of household head, settlement status, size of oil palm plot, oil palm age and oil palm age square. Our findings suggest although contract smallholders allocate a higher cost per hectare for input, a higher price and a higher yield more than compensate for this, resulting in higher net revenue per hectare. The results show that, in general contract farming has positive and significant impact on per capita income. It is estimated that participation is able to increase per capita income by at least 52 %. However, by classifying samples into two groups on the basis of total asset further analysis shows that there is a different effect of participation for different groups. The effect of participation is positively significant for the group that owns total asset equal or more than Rp 375 million (around US $ 41,000) but it is not significant for group that owns total asset below the threshold. This difference is critical for policy implication.

Keywords: Contract farming, oil palm, propensity score matching, treatment effect model

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Economic Analysis of Agroforestry in the Visayas, Philippines under Consideration of Conservation of Natural Resources

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Increasingly, people in the Visayas, Philippines are migrating from fertile lowland areas, where land is scarce, to more remote hillside areas. Such migration, together with inherent high population growth, is forcing a transformation in land use from subsistence to permanent agriculture on fragile slopes and is creating a new suite of social, economic, and environmental problems.

The economic activities of the Visayas people are mainly agriculture, either for self-consumption or commercial sales on the local market. These people belong to the poorest people in the Philippines. Figures for their annual income range from 15000 (approx. 240 Euro) to 25000 Pesos (approx. 400 Euro) per household. Their standard of living is often low and is highly vulnerable due to exploitative land cultivation. The areas where they settle are former forest areas with important environmental functions such as water and carbon storage and biodiversity. Agricultural practices are often unsustainable such as slash and burn practices or mono-cropping practices. The effects are high deforestation and natural resource degradation rates (soil erosion and reduced watershed function).

Community forestry and agrarian reform programs have been developed as a means of addressing the links between forest degradation and poverty by granting households limited access to government-owned forest lands. Reviews of these programs have suggested the need to better understand rural households and their diversity to improve the design, implementation, and monitoring of (agro)forestry and other development programs in rural areas.

High potential exists in increasing incomes by using agroforestry practices, including a wider variety of different crops and better crop and input management practices.

The development of economically sustainable agroforestry practices is essential in tackling these challenges. Sustainable agroforestry systems have to include high profitable measures to optimise smallholders' income, reduce vulnerability to external events and guarantee a necessary income in the first years after the system is established.

Keywords: Agroforestry, external effects, German Development Cooperation, Philippines, profitability analysis, uplands

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Can the Reforestation Projects Stop the Extraction of Timber from the Protected Forest Chongón-Colonche?

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In September 1994, the mountain range Chongón-Colonche was declared "Protected Forest and Vegetation" (PFCC) with the aim of achieving conservation of the Premountain Humid Forest (pm HF), Tropical Dry Forest and protection of the microbasins as water sources to the rivers in the area. As a strategy in order to compensate for the extraction of wood, forest plantations were promoted since 1998 underneath different systems in the area of the BsT in the region of the mountain range Chongón-Colonche. In those plantations a total of 45 species have been used, where most of them were native trees in an area of 2,231 ha. This investigation has an objective to present a growth development evaluation of the species with fast and moderate growth as well as a socio-economic analysis. The use of 45 species of trees shows that the project objectives of reforestation were not clear when speaking of: protected reforestation or the rehabilitation in terms of the management of micro-basins, commercial reforestation of the production of quality wood, or social reforestation that could be viewed as short and/or medium term compensation to stop the extraction of timber from PFCC. When the general objective of the project is not related to the management of the natural resources but instead linked to creating employment, it is not possible to achieve the objectives of conservation. Based on the analytical framework of benefit cost analysis, the only species that presented an economic benefit were those who grew fast. The short term economic returns of land and labour from forestation were substantially lower than those generated from cash crop production in the research area. The use of incentives is often attached to technical solutions defined by a top-down approach based on developed technologies with little participation. For this reason a participatory development of technology should be emphasised in range and education instead of direct incentives. Finally, despite the existence of de facto conservation (protected forest), on-farm conservation (as a public conservation strategy) could be a viable alternative for moderate and slow growing species with valuable timber.

Keywords: Annual mean increment, current annual increment, moderate and fast growing trees, protected forest, tropical dry forest

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Agroforestry Experiences in the semi-Arid Zone of Brazil: Quality of Life, Food Security and Nature Conservation

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The Brazilian semi-arid zone and its Caatinga is one of the most depredated and least protected area of the country. Despite the difficult geoclimatic characteristics (*i.e.* limited and irregular rainfall regime, high evaporation rate, crystalline sub-soil), the region is densely populated (12 millions of inhabitants) and rely considerably on farming activities. Besides, decades of socioeconomic inequalities, environmental degradation and inadequate policies
have left a great part of the population in precarious and vulnerable socioeconomic situations.

This study aims to analyse the different benefits provided by sucessional agroforestry systems – model based on the observation of the local ecosystem and imitation of the natural succession processes – in small family farms of the region. We studied the effects on the food and economic security of these families and on the conservation of the Caatinga, and also tried to capture the farmers' perceptions of their quality of life.

From April to July 2009, semi-structured interviews with six families of farmers were conducted in Bahia, Pernambuco and Ceara. We registered their techniques and made an inventory of the species cultivated. For the analysis of the quality of life of the families, we used the definition of the World Health Organisation Quality of Life (WHOQOL), *i.e.* evaluating the farmers' perceptions of their physical and emotional conditions, their environment and, finally, the quality of their social relations and role in the society. We observed a direct link between this agricultural model and the environmental, food, economic, health and social security of these farmers. An average of 86 species were cultivated in each of the six farms, demonstrating an important agrobiodiversity and a less
economically and environmentally vulnerable system. We also observed a positive change in the farmers' perceptions of their role and responsibility in the society (provision of healthy food and preservation of nature).

Keywords: Agroforestry, biodiversity conservation, food security, quality of life, small farming

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Water and irrigation

Water Resources for the Production Systems on the Margin

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Rising population, growing economic activities, rapid urbanisation, changing lifestyles, rapidly increasing demand for food coupled with changing consumption patterns, growing demand for bio energy have all combined together to put greater pressure on available water resources. Demand for water is fast overtaking the available supply. The impending climate change projections have made the situation scarier. Many countries in the world have already been facing or are destined to face serious water shortages in the near future.

India, the second most populous countries in the world, is likely to face acute water scarcity. The estimated demand for water in India is set to surpass the available water supplies from all sources by 2025 threatening food security and economic development. India faces a turbulent water future. The current water development and management system is not sustainable. Unless dramatic changes are made and made soon in the way in which government manages water, India will neither have the cash to maintain and build new infrastructure nor the water required for the economy and the people.

The present talk focuses on two major questions facing India's water economy:

(a) what are the major water development and management challenges facing India? and

(b) what are the critical measures that can be taken to address these challenges?

The presentation describes the evolution of the management of India's water, describes the achievements of the past and identifies a looming set of challenges. The presentation then discusses what changes need to be considered to deal with these challenges and how to manage the transition from the 'ways of the past' to the 'ways of the future' so that a more sustainable path of water development and management can emerge.

Keywords: Bio energy, climate change

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Evaluation of Small-Scale Irrigation and Wua Interventions in Eastern Madagascar: A Comparison of Qualitative Strategies

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Small-scale irrigation systems (SIS) and water user associations (WUA) are key instruments to enhance food security, rural income and livelihoods in agricultural development. Current monitoring and evaluation (M&E) methods for SIS/WUA mainly use limited quantitative data that are difficult to obtain and often come up short in assessing true sustainability. Our research proposes qualitative methods to evaluate SIS/WUA.

First a set of qualitative sustainability indicators and associated variables for SISs/ WUAs are proposed. Six composite indicators were produced: (1) water governance, **(2)** technical competence, **(3)** functional competence, (4) participation, (5) viability and (6) impact/benefit. Two qualitative evaluation strategies were then applied: (1) 90 in-depth WUA member interviews and participatory observation techniques (extended field visits, case studies, and trained observer ratings); and (2) 75 rapid surveys of members within the same WUAs. Strategies were applied to 10 WUAs in eastern Madagascar affiliated with an integrated poverty reduction programme sponsored by IFAD and targeting subsistence rice farmers. Variable values were weighted and summed for interviews and surveys to arrive at an overall sustainability value (s-val) index for irrigators and WUAs. Participatory observation techniques prove the resulting s-val index as a legitimate monitoring tool to assess SIS/WUA.

Secondly, this work measures the concurrence between collection methods (interviews and surveys) to determine if they are interchangeable. Typologies, data triangulation and statistical analysis were used for this task. Typologies were created and analysed using a (1) key variable qualitative method, (2) best and least performing WUA and (3) an agglomerative hierarchical clustering (AHC) method.

Typologies confirm s-val as a sound sustainability index. Differences were found between global s-val means for surveys and interviews though both samples fit a normal distribution pattern. Discrepancies are attributed to incoherency of certain variables between members of the evaluation team. Statistical t-test results of interview and survey data samples indicate statistical similarity between the two collection methods when incongruities are accounted for. Interpretation and judgment of the typologies and statistical analysis results were triangulated with participatory observations, trained observer ratings and case studies.

This work defends the legitimacy of an integrated qualitative evaluation based on sound social theory, data collection and analysis tools.

Keywords: Indicators, irrigation, participation, qualitative evaluation, sustainability

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Participation of Tree-crop Farmers in Spot Water Markets in semi-Arid Areas: An Example from Iran

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Water markets have been proposed as a tool for dealing with water scarcity and have been justified by emphasising their efficiency. Market-based allocation systems have the potential to ensure that the scarce water will flow to the user who earns the highest marginal value from the water. However, the number of recorded instances where water supply problems are solved by market-based systems remains limited. This study attempts to identify the decisive factors that motivate farmers' participation in spot water markets in the Rafsanjan aquifer in southeastern Iran. The precipitation level is very low in this region (90 mm annually), and the main source of water is groundwater. A two-stage random sampling was carried out in a field study from November 2008 - February 2009. In this survey, information was collected regarding groundwater quality and the annual production and cost of the pistachio gardens, as well as detailed technical and economic information about the pump or well. Additionally, the garden structure, land-water ownership, and socioeconomic characteristics of the farming household or landlord were included in the survey. A Logit model for the binary participation variable is used to test the factors affecting farmers' decisions to buy groundwater from neighbours who share the same pump. Both farmer characteristics and technical variables are considered as explanatory variables. The results show that the technical variables contribute substantially to the participation decision. E.g., a decrease in water quality, an increase in the age of the garden, and an increase in the size of the water quota reduce the probability of participation. In contrast, more scattered plots, a higher water flow level of pump, and a deeper well increase the probability of participation in spot water markets. Additionally, the application of the spatial Moran's I test on the residuals of regression shows no spatial effect inside the model. This study shows that water scarcity and improvement of water quality increase the probability of participation in water markets. Finally, the results suggest that in this area the participation in water markets is motivated more by profit increasing factors than by farmer characters.

Keywords: Groundwater, logit model, participation, pistachio, pumps, spot water market, water quality

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Innovative Water Saving Irrigation Technology by Auto-regulative Subsurface Pipes

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According to Food and Agriculture Organisation of the United Nations (FAO) irrigation consumes 70% of surface and groundwater withdrawals of the world. In developing countries this value may attain 95 %. Due to irrigation, climate change and population growth, in many countries water consumption exceeds the renewable water resources, leading to widespread groundwater depletion and water scarcity. It can be assumed that current irrigation methods use only a minor portion of the applied water, and that losses up to 60 % due to percolation, evaporation and water mis-management are common.

The authors present a BMBF joint research project dealing with an innovative approach to water-saving irrigation, based on porous irrigation pipes as an upgrade of both subsurface and traditional pot irrigation. Clay pot (pitcher) irrigation is a type of subsurface irrigation. The unglazed porous clay pot is embedded in the ground and filled with water, which eventually drains through the porous pot wall. Savings of up to 70% compared with conventional irrigation methods were observed, as well as a significant reduction of fertiliser requirements.

In the BMBF joint research project (partners comprise both Algerian, Kenyan and German Universities, GIZ, DITSL, C.R.S.T.R.A (Research Center for Science and Technologies in Arid regions), German industry companies) which investigates in an effective subsurface irrigation technology following the pot-irrigation principle. Due to the specific material properties, the irrigation pipes are auto-regulative, *i.e.* they release water depending on soil moisture and thus the plants' water demand. This innovative irrigation technology will be field-tested in Algeria and Kenya from 2011 through 2013.

The irrigation method offers an easy-to-use low-tech system. Compared with existing irrigation methods, the system owns a high saving potential in terms of water consumption as well as operating costs. It is easy to handle and to maintain and environmentally sustainable. Against the background of the steady worsening of agricultural water supply, the project has a share in providing water and food security and thus prevents the spreading of poverty.

Preliminary research works on the method of operation and laboratory tests providing first quantitative results will be presented.

Keywords: Auto-regulative technology, irrigation, subsurface irrigation, water ressoureces

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Impact of Climatic Conditions on Rice Yield under Water-saving Irrigation in the Sahel

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Interest in water-saving irrigation techniques in Senegal is rising from the aim to increase the domestic rice production and thus becoming self-sufficient via rice-rice double-cropping and expansion of the rice growing area and also from high irrigation costs due to increasing fuel and electricity prices.

Since climatic conditions in the Sahel are highly variable in the course of the year, we investigated water input, yield and water productivity of five selected genotypes under flooded and water-saving conditions in eleven bi-monthly staggered sowing dates, year-around. Experiments were conducted between November 2008 and October 2010 in Ndiaye, located in the Senegal River delta, with typical Sahelian climatic conditions and thus three distinct seasons: a hot-dry-season from March to July, a short wet-season from August to October and a cold-dry-season from November to February.

Yield reductions under water-saving irrigation were larger for most of the varieties after sowing in the cold-season, while sowing in the hot-dry-season and wet-season led to minor yield penalties compared to the continuously flooded treatment. Water productivity was increased in the water-saving treatment compared to flooded conditions after sowing in the hot-dry-season, whereas sowing in the cold-season lead to comparable water productivity in the water-saving as well as in the flooded treatment. Since yield losses under water-saving conditions varied widely between the different seasons, we concluded that climatic conditions are a major determinant for performance of rice grown under water-saving conditions. Whereas extremely high vapour pressure deficits and thus an increased evaporative demand are leading rapidly to soil water deficits in the hot-dry-season, low minimum temperatures that are not buffered by a floodwater layer are resulting in decelerated development in the cold-season. The impact of weather parameters and microclimate on crop performance under water-saving irrigation will be presented and genotype-specific responses discussed.

Keywords: GxE interactions, lowland rice, Sahel, water-saving irrigation

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Agricultural Foreign Direct Investment and Water Rights of Marginalised Smallholders – An Institutional Analysis from Ethiopia

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In the last years, the trend of foreign actors securing land for agricultural production has increased substantially. This phenomenon, often termed "land-grabbing", especially occurs in low-income countries such as Ethiopia in areas where marginalised smallholders practise subsistence agriculture. Acquiring access to water resources is one of the major goals of foreign investors, leading to a re-negotiation of water rights between local actors and foreign investors. Despite water being the vital source of livelihood, the consequences of "land-grabbing" on the local water governance system of marginalised smallholders has so far not been adequately analysed. This paper presents an institutional analysis of a small-scale irrigation scheme in Ethiopia, where foreign horticultural farms started to use water from an irrigation canal that was formerly managed as a user-group common-pool resource by local smallholders. The analysis aims at answering the questions as to how and why institutional change occurs when agricultural foreign direct investment takes place, and which are the impacts of this institutional change for marginalised smallholders.

The study follows a qualitative case-study approach with semi-structured interviews as the main source of data. For the analysis, common-pool resource theory and the bargaining theory of institutional change are employed.

The study found that the former common-pool resource management system of local farmers and its associated water rights changed in the way that most of the identified water rights shifted to the investment farms, leading to a further marginalisation of local smallholders. The new arrangement was found to be inefficient, with interactions between both actors being characterised by mutual distrust, conflict, and corruption.

The change in the institutional arrangement is explained as a consequence of different bargaining power resources, which led to a stronger position of the investment farms. When investigating institutional arrangements and the role of marginalised small-scale farmers, the actors' bargaining power resources are therefore highly important to be considered.

Keywords: Foreign direct investment, institutions, water rights

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Understanding the Farmer's Behaviour towards Water Saving Irrigation Technologies

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The North China Plain (NCP) is one of the most important areas of agricultural production in China but most of its agricultural production depend on irrigation. An intensive double cropping system*i.e.*, winter wheat and summer maize has made this region as the major grain provider of China. Therefore, it is also been called as the bowl of China, providing about one fifth of China's total food production. With the dwindling western mountain runoff and drying up of many perennial rivers, groundwater has become the only reliable water resource and agricultural development is now totally dependent on groundwater. This lead to the decline in the groundwater water at an average rate of about 1–1.5 m year^{-1}.

Previous studies suggested that there are several possibilities to optimise the cropping system so as to achieve high yields while still focusing on sustainable water use. For example, changes in irrigation schedules, cropping systems and irrigation technology will help to reduce the water consumption which is generated by agriculture. This raises many questions, concerning the farmer's irrigation strategies, perspective and their behaviour towards irrigation management practices. The objective of this study is to find out those factors which affect the farmer's decision on irrigation management. A qualitative survey was conducted in the Hebei province, to assess the irrigation method, socio-economic factors and the awareness of the water problem. Later, a regression model is used and price of water pumping and lack of awareness about water shortage were found out to be the major factors influencing the present irrigation practices in this region. Additionally, benefits of applying water saving irrigation technology should be clearly introduced to the farmers not only in terms of economical benefits but also in terms of the necessity for sustainable development of agriculture specialised in irrigation water. It is also suggested that technical extension services and training will help to improve the farmer's awareness of the present irrigation situation and their knowledge of water saving irrigation methods. Finally, without technical and adequate financial support, farmers are less likely to change.

Keywords: Irrigation, North China Plain, sustainable agricultural production, water saving technologies

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Simulation of Water Productivity for Maize under Drip Irrigation

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Water has become increasingly scarce in most of the countries in the world. To use the available water efficiently in crop production, agricultural water productivity (WP) need to be improved. Drip irrigation systems and deficit irrigation practices are the most efficient methods in improving WP. Availability of soil-water-crop simulation and climatic models can also help in the efforts to improve WP. A study was conducted in Morogoro using CROPWAT model to simulate water productivity of maize under drip irrigation by supplying different water deficits. A completely randomised block design was used with three replications and four treatments. The treatments were T1, T2, T3 and T4 representing 60, 40, 20, 0 percent deficit of ETC (crop evapotranspiration) respectively. Biomass accumulation (at 45 and 75 days after planting; DAP), grain yield and harvest index were determined for each treatment and experimental yield reductions were calculated. The CROPWAT simulation was done for each water deficit level and yield reductions were recorded. A comparison was made between experimental and simulated yield reductions. The mean biomass production between the treatments at 45 DAP were not significant different ($p < 0.05$). At 75 DAP mean biomass production (0.684, 0.728, 1.049, 1.378 $\mathrm{kg\,m^{-2}}$ for T1, T2, T3 and T4 respectively) were highly significant different ($p < 0.05$). The mean grain yield between treatments, mean water productivity (1.67, 2.2, 1.78, 1.72 $\mathrm{kg\,m^{-3}}$ for T1, T2, T3 and T4 respectively) and harvest index values were significant different ($p < 0.01$). Experimental and CROPWAT simulated yield reductions were not significant different ($p < 0.01$) at all stages for all the treatments. The CROPWAT model adequately simulated the experimental yield response to water for maize (maize water productivity).

Keywords: CROPWAT model, deficit irrigation, simulation, water productivity

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Using the Aquacrop Model to Optimise Deficit Irrigation Scheduling of Cotton in Uzbekistan

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The global water demand for irrigated agriculture, municipal and industrial consumption mainly driven by population growth is increasing against limited fresh water resources. To cope with the disadvantageous impacts of climate change on water resources availability and to fulfil water demands by ecosystems is challenging water management. Irrigated agriculture, by far the biggest water user with low efficiency, is therefore under high pressure to increase water productivity. For rational management of limited water supply, advanced irrigation scheduling and innovative technologies are needed. Various models aiming at crop water management for irrigated and rainfed conditions have been developed. Whether simple such as CROPWAT or sophisticated such as APSIM, CROPSYSTs etc., their problem is either limited quality of results or high demand for input data. Conversely, AquaCrop is a promising approach which simulates achievable yields of major crops as a function of water consumption under rainfed, supplemental, deficit, and full irrigation conditions, with comparatively justifiable data demand. To derive both the optimal irrigation schedule and optimise the deficit irrigation schedule for cotton, AquaCrop was used in Khorezm/Uzbekistan. The novelty of this study lies in the fact that the Hydrus-1D model was used to quantify the daily capillary rise due to shallow groundwater, because combined with AquaCrop it can overcome the missing consideration of the capillary rise in the standard version of AquaCrop. Alongside optimal irrigation schedule, deficit strategies were also derived in two ways 1) proportionally reduced water supply (RWS) of 20, 40, 50 and 60 % throughout the crop growth and 2) introduction of stress at specific crop growth stages. The results show that proportionally RWS of 40, 50 and 60 % resulted into 14, 30 and 48 % yield reduction respectively. During stress at the late crop development stage, a RWS of 12 % resulted in a yield increase of 8%. Conversely, during stress at the earlier crop development stage, yield loss was 17 %. During water stress at the late ripening stage, no yield loss was observed. In conclusion, AquaCrop is a useful tool in irrigation management under water scarcity conditions at field and scheme level.

Keywords: AquaCrop, deficit irrigation, irrigation scheduling, water scarcity

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Effect of Different Irrigation Techniques on Microclimate in Winter Wheat Canopies in the North China Plain

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Winter wheat is regarded as a staple crop in the North China Plain (NCP). The region comprises 65 % of country's total arable land with only 20 % of country's total water resources, making water scarcity as one of the major problems for the agricultural productivity in NCP. The dominant cropping system in the NCP is winter wheat (*Triticum aestivum* L.) and summer maize (*Zea mays* L.) double cropping systems. Usually, winter wheat is being sowed in early October and harvested in early June. The rainfall during the wheat growing period covers only 25–40 % of the crop water requirement, making supplemental irrigation inevitable for maintaining high yield. In contrast, 70–80 % of the mean annual rainfall in the region is concentrated in the summer months (July to September), which is the maize growing season. With the lack of surface water, groundwater has been used for irrigation for many years. As a result, groundwater table has been persistently declining at an average rate of about 1–1.5 m year^{-1}.

Winter wheat in NCP is mostly irrigated via surface irrigation techniques. Alternative irrigation systems like sprinkler and drip irrigation are the advanced irrigation techniques for water saving and precision irrigation scheduling have been seldom used in the NCP. However, crop yield and water use efficiency (WUE) in low-flow irrigated fields are higher than that in high-flow irrigated fields as the former technique can produce a favourable microclimate for crop growth, by reducing crop transpiration by more than 50 % during the irrigation period.The field trails were conducted at Wuqiao experimental station, Hebei province, China. Temperature and humidity sensors were placed at three different heights of the canopy and the canopy temperature was measured by infrared camera. The objective of this work is to study the physiological changes of the winter wheat throughout the growing period caused by the microclimatic changes under drip, sprinkler and surface irrigation techniques. Other specific objectives include the effect of different irrigation techniques on yield and biomass production. Preliminary results showed that air temperature and vapour pressure deficit in canopy decreased significantly during and following sprinkler irrigation compared to drip and surface irrigation methods.

Keywords: Canopy temperature, irrigation, microclimate, vapour pressure deficit

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Winter Wheat Production under Different Irrigation Techniques in North China Plain

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North China Plain (NCP) is regarded as one of the most important agricultural production region in China, having double cropping system *i.e.* winter wheat and summer maize. These crops are usually cultivated and irrigated with the conventional farming practices. The rainfall during the wheat growing season covers only 25–40 % of the crop water requirement. Micro irrigation systems such as drip or sprinkler irrigation are known for its water use efficiency (WUE). However, these irrigation techniques are rarely applied by the farmers in NCP.

The objective of the study was to determine the yield and biomass production of winter wheat crop under different irrigation methods such as drip, sprinkler and flood irrigation. The field experiments were carried out at Wuqiao experimental station, Hebei province, China. The experimental field (130 m × 23 m) was divided into 9 equal plots (40 m × 7 m). Three irrigation treatments namely drip; sprinkler and flood were replicated three times. The results showed that the rate of soil moisture decline at the upper soil surface under drip irrigation was the least as compared to sprinkler and flood irrigation. The biomass produced under drip and sprinkler irrigation was 7 and 3 % higher when compared to flood irrigation. The crop height observed under drip irrigation was 5–12 % higher than that of sprinkler and flood irrigation. Similarly, the yield obtained under drip and sprinkler irrigation was 8.63 and 7.75 % higher than that of flood irrigation. The weight of one thousand grains produced under drip, sprinkler and flood irrigation was recorded to be 43.36, 42.17 and 41.17 g respectively. In all, the increase in WUE under drip irrigation was apparent from the results as compared to sprinkler and flood irrigation respectively.

Keywords: Drip irrigation, sprinkler irrigation, water use efficiency, winter wheat, yield

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Domestic Blue and Green Virtual Water Transfers in China: Is Water Scarcity Really a Driver?

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This study contributes to the research field of virtual water by estimating the blue and green virtual water transfers within China, a country with severe regional water scarcity problems. Due to the lack of data from official statistics, model outputs from the economic land use model MAgPIE (Model of agricultural production and its impact on the environment) are used to estimate inner-Chinese trade. Virtual blue and green water transfers are then estimated using blue and green water consumption values from the biophysical crop and vegetation model LPJmL (Lund-Potsdam-Jena managed Land Dynamic Global Vegetation and Water Balance Model).

Production patterns for the year 2005 for 15 food crop groups are delivered on a 0.5° resolution by MAgPIE_trade, which are used to calculate the surplus or deficit, as a result of a supply and demand equation, for 8 sub-regions in China. After accounting for international trade, trade flows within China underlie the assumption, that deficits are met with the excess volumes produced in the sub-regions with food surplus. Using crop-specific virtual water contents derived from the crop and vegetation model LPJmL on a 0.5° resolution, product trade flows can be transformed into blue and green water transfers.

On the basis of the results, the following questions will be answered: Does virtual water "flow" from water abundant to water scarce regions within China and how big is the throughput? What is the share of green and blue virtual water transfers? Which scarce resources drive domestic trade?

In recent literature, international trade is discussed as one option for regional water management. Results of this study give necessary information to evaluate the potential of the virtual water transfers, for the special case of food production, trade and large scale water management within China.

Keywords: China, virtual water

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Analysis of Water Footprint in Bangladesh Dairy Farms: An Implication of Food Security

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Water availability is the world's most emerging issue as this is the most precious life-sustaining element which cannot be substituted by others. Thus, the competition for scarce agricultural water resources is becoming intense partly due to burgeoning population growth, with changing eating pattern for better-tasting food and a concomitant increase in water use for agriculture. The value for water use in agriculture ranges between 67–87 % of total water withdrawals. This value varies from continent to continent. The World Water Development report stated that the poorer countries use 82% of thier total water withdrawals for agriculture.

Dairying significantly consumes water and decreases its availability thereby risking food security. This is a big challenge for countries like Bangladesh (BD), India and China where excessive ground water is withdrawn through irrigation. The aim of this study is: i) to analyse different segments of "water use" (WU), ii) identify the main drivers of WU and to quantify the dependence of irrigation water and imported "virtual water" (VW) in BD dairying.

An extended version of the TIPI-CAL (Technology Impact Policy Impact Calculations) of the International Farm Comparison Network (IFCN) was used for this analysis. To calculate VW consumed from purchased feed, the co-efficient was used as VW trade concept as farmers import feed and fodder from interregional and outside of the country. The statistical methods were employed to quantify rain-fed and irrigation WU to grow home-grown concentrate and roughage. In BD, most of the feed and fodder is used from by-products of cereal crops (*e.g.* rice straw) as input for milk production. Total water used is allocated between the main and the by-product in proportion to the revenue generated from these products.

The results show the total water foodprint (WF; litres/kg milk) of 1924 and 2297 for a 2-cow farm and a 14-cow farm respectively. More than 95 % water is used through feeds and <5 % through others like drinking and servicing. Irrigation water has the biggest share of water (45 %) when considering sources. Finally, large farm need more WF/kg milk as they rear more animals but productivity per animal is not significantly higher than small typical farm. WF is an important indicator for efficient water resource utilisation that augments food production. Further research is necessary to do an impact assessment based on WF related to regional water scarcity and objective way to manage water that will increase efficiency in dairy production.

Keywords: Bangladesh, dairy production, food security, typical farm, virtual water, water footprint

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Energy Efficiency Governance in the Times of Subsidised Irrigation Power in Andhra Pradesh (India)

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High in-efficiency of electricity distribution and consumption in irrigation schemes in Andhra Pradesh (India) continues to be a challenge because of various reasons like unmetered subsidised power, poor infrastructure, high aggregate transmission and distribution losses, irregular power etc. The study underlines that in order to achieve efficiency and overcome these barriers, it is necessary to analyse the energy efficiency governance structure. In the absence of appropriate governance structure even the best market mechanism and incentive fails to show its impact. Energy efficiency in the present context cannot be achieved without a collective action of a large number of individual actors in society and hence requires a more decentralised governance mechanism with increased participation of involved stakeholders.

Currently different implementation mechanism are being followed for enhancing energy efficiency in the irrigation sector like direct subsidies on efficient equipments, demand side management programs initiated by electricity distribution companies and public private partnership models based on performance contracts. The analytical framework of Institutions of Sustainability (IoS) is applied to analyse the complex linkages between technical, social and institutional arrangements of efficiency enhancement in irrigation electricity distribution networks and consumption. A new component of technology is added to the framework, and then we define the action arena to be composed of attributes of three sub-systems namely technical (hardware and software), social (actors and their interaction) and institutional (rules of game). Thus, the study examines the limitation and impact of different energy efficiency governance structures by dissecting the characteristics of actors, energy efficiency transactions and institutions. Adopting a comparative case study approach the paper analyses the different dimensions of energy efficiency governance and identifies the effective institutional structure for the delivery of enhanced energy efficiency.

Keywords: Energy efficiency governance, institutions of sustainability, irrigation electricity, socio-technical system

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Global Map of Irrigation Areas – Version 5.0

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Irrigation accounts for roughly 90 % of the global consumptive water use and nearly 20 % of all cultivated areas worldwide are equipped for irrigation purposes. Therefore, the quantity of irrigation and its spatial distribution is an important factor in calculating water balances, modelling of complex ecosystems or agricultural water use and its consequences for the global water cycle.
The intention of this work is to provide this information in form of a global raster dataset, by compiling statistical data of irrigation quantity with spatial datasets. Each grid cell contains a percentage value of area equipped for irrigation. The spatial resolution of the final product has a five arc minutes by five arc minutes grid cell size. The calculation was done on a one minute grid. For data handling purposes on a global scale the dataset was generalised afterwards, but is still available in the more detailed version.
The vast majority of the input data is open source. Statistical data was provided by international organisations and local governments and has been combined with spatial datasets taken from local authorities, local irrigation projects, global satellite images or global land use datasets. The spatial data from various sources and data types have been prioritised with levels from ten to one and then used according its priority to locate the amount of irrigated areas provide by the statistics.
The final product will be open to the public via the FAO Website. The updated version 5.0 includes more detailed datasets for the regions of Africa, America, Asia and Oceania.
This dataset is provided to benefit a large variety of other projects dealing with ecosystem modelling, water use, food production, climate change and related topics.

Keywords: Agriculture, digital map, global map, irrigated areas, spatial modelling

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Water Markets for Efficient Water Allocation in Central Asia

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Inefficient use of water and land resources in Central Asia under the Soviet planning system is the main cause of present ecological problems such as soil and groundwater salinisation, water logging, and desiccation of the Aral Sea. In the post-soviet era, different and conflicting interests in this region have further aggravated water distribution problems. Extreme intra-country dependence of economic, infrastructural and water distribution systems in these states also do not allow achieving efficient resource use without cooperation. However, cooperation would not occur without trust and potential mutual benefits. Water markets and the possibility of water trade by riparian countries would most likely promote the governments of Central Asian states to cooperate and consequently result in more economic gains with less water. To analyse the potentials of water markets on more efficient water use and water saving technology adoption, a two-stage hydro-economic model for the case of Amu Darya River Basin is developed. At first, a non-linear optimal crop allocation model with the objective of maximising benefit given the constraints on inputs such as fertiliser, machinery, labour, and water is developed for each water user site separately. Several model simulations results are generated to estimate the function for the relationship between the profit and water under different water availability scenarios. In the second step, these profit functions are used together with river water balance model to construct a basin level hydro-economic model. The final model was used to run baseline and water market based scenarios. Results indicate higher overall profits from water markets. Water is transferred from less efficient water use activities to more efficient water use activities while compensating the losses of less efficient water users from increased benefits of more efficient water users. Moreover, introduction of water markets under water scarce conditions results in increased adoption of water saving technologies. In sum, institutional change in the Amu Darya Basin, for instance, introduction of water markets and water trade by riparian countries may contribute to more efficient and sustainable water resources use in this region.

Keywords: Amu Darya River, hydro-economic model, water distribution, water profit function, water saving technology

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Groundwater Pollution by Pesticides in a Watershed in Northern Vietnam

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During the last decade, high population growth and export-oriented economics in Vietnam have led to a major intensification of rice production. In Vietnam, there is concern that lowland and upland paddy rice production systems are the major non-point sources of pesticide pollution of groundwater, which is often used for domestic purposes. Pesticides are toxic by design, calling for monitoring their impact on human health and environmental quality.

Against this background, the present study aimed at measuring temporal and spatial groundwater pollution patterns of pesticides in the mountainous Chieng Khoi watershed in northern Vietnam. During two rice cropping seasons in 2010, we monitored concentrations of five commonly applied pesticides (imidacloprid, fenitrothion, fenobucarb, trichlorfon, and dichlorvos) in 16 wells and one natural spring. The wells and the spring are serving domestic and drinking water for the local population. Furthermore, we conducted an extensive field survey among rice farmers to gain knowledge about current pesticide use, application practices and water consumption habits.

During the monitoring periods, all target pesticides were detected in the groundwater. At this, 27 % (spring season, n=97) and 35 % (summer season, n=105) of the analysed water samples showed pesticide concentrations above the detection limit. The pesticide concentration of 22 % and 31 % of samples exceeded 0.1 μg l^{-1}, the European drinking water quality standard. Peak concentrations of 2.1 μg l^{-1} and 4.0 μg l^{-1} were detected for Imidacloprid during the spring and the summer season, respectively.

In our presentation, we will give a summary of the experimental setup and focus on key results providing evidence that under the current management practices, pesticide use in paddy fields poses a serious environmental problem in mountainous regions of northern Vietnam.

Keywords: Groundwater pollution, northern Vietnam, paddy rice production, pesticides

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Removal of Metalaxyl-m by Organically Modified Sediment from Aqueous Solution

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Re-use of marginal water such as drainage- and/or waste-water in agricultural field is an alternative solution for developing and emerging countries to overcome limitations in fresh irrigation water. One of the most important problems is that the marginal water has different types and amounts of pollutants with negative effects on the environment. Long term environmentally safe usage of this water is possible after removing these pollutants. This study is focusing on the use of cost effective and environmentally friendly adsorbents to remove organic pollutants from aqueous solutions.

Natural bentonitic clay sediment (bent) instead of standard montmorillonite clay minerals have been proposed in combination with natural organic modifiers, humic acid (HA) and L-Cystinedimethylester (Cystin), and synthetic organic modifiers, Methyltriphenylphos-phonium (MTP) and Hexadecyltrimethyl-ammonium (HDTM), to adsorb the fungicide Metalaxyl-m (MM) from aqueous solution. Metalaxyl-m, (methyl N-(2,6-dimethylphenyl)-N-(methoxyacetyl)-D-alaninate) a systemic fungicide, is used to control a wide range of fungal diseases in many field crops and vegetables and it represents a typical example of organic pollutants in the drainage water.

Changes in clay properties after modification with the organic modifiers have been detected by X-ray diffraction (XRD) and total carbon (TC) analyses. From the XRD pattern, the basal spacing of the bentonitic sediment increased from 14.6 to 15.1, 16.9 and 19.5 Å after the treatment with HA, MTP and HDTM, respectively. Total organic carbon of the modified sediments followed the sequence of HDTM- $>$ MTP- $>$ Cystin- $>$ HA-bent $>$ untreated sediment. Loading the sediments with the organic modifiers improved the adsorbed amount of the MM relative to that obtained by the untreated sediment. Among the treatments, sediment modified with cystin and HDTM had the highest adsorption of MM, reaching the 2.7 and 2.3 fold, respectively, as compared with the untreated sediment. Isotherms of metalaxyl-m adsorption showed that Freundlich equation is the model fitting to the observed data with correlation coefficient (R^2) between 0.960 - 0.997.

Keywords: Clay sediment, metalaxyl-m, organic modifier

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Farmer Perceptions on Economic Costs of Wastewater Irrigation in Hyderabad, India

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In Hyderabad, India – as in many developing regions – significant amounts of sewage and industrial wastewater are diverted into natural water bodies, largely without prior treatment. As this water is used by farmers, health risks are likely, but economic advantages from wastewater use due to less fertiliser requirements or reduced electricity/fuel expenditures compared to pumping groundwater cannot be ignored.
This study focused on selected economic effects of wastewater irrigation along a 40-km downstream stretch of the Musi river, which becomes a sewage channel, especially in the dry season. The research area comprises settlements where both wastewater and groundwater irrigation are common. Data on irrigation, crop yields, agricultural prices, labor and fertiliser use collected by several institutions were cross-checked with farmers and market data. Crop cultivation in the area comprises mostly of paddy (ca. 72 % of agricultural land) and paragrass for the dairy industry (26 %).
Among rice farmers fertiliser application was higher among groundwater users, while many paragrass farmers did not use any fertiliser. Those who used it had similar costs as groundwater users. Thus wastewater use is not an economic advantage. The result was similar for pumping which equally concerned wastewater users, as the river water has to be lifted to the fields. In general, electricity costs were subsidised and hence low for both water sources. Often the remaining costs were included in the land rent and paid by the land owner.
Paddy farmers noticed a decline in rice quality when using river water, which has been explained with the high salinity, metal and nitrogen levels of the wastewater. This has a strong economic impact as low quality rice attracts up to 50% less revenue. A resulting shift in crop selection from paddy to paragrass was registered while other farmers changed rice varieties, stopped fertiliser use or mixed river and groundwater. All interviewed farmers would prefer access to clean water sources. Positive economic effects of wastewater use appear to be limited to those areas without groundwater access.

Keywords: Agricultural economics, farmer perceptions, urban agriculture, wastewater irrigation

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Off-site Cost and Benefit of Sedimentation in the Eastern Side of Inle Lake Watershed, Myanmar

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The off-site cost and benefit of sedimentation in the eastern side of Inle Lake Watershed at Nyaung Shwe Township, Myanmar were estimated and compared. The average actual government expenditure for construction of sediment trap dams on streams flowing into the lake and for dredging the sediment inside the lake was determined as the total off-site cost associated with the sedimentation of the lake. In 2006 constant terms, total actual average off-site cost amounted to US$ 6,261, which is the sum of construction cost of sediment trap dam, US$ 2,467 to trap 5,080m^3 of sediment and the dredging cost US$ 3,796 to dredge 30,579 m^3 sediments from the lake to ensure enough depth for public waterway and cultural activities in the lake.

Off-site benefit of sedimentation was determined by the valuation of silt soil which is used in the floating tomato garden in terms of the value of garden soil to be used as the growing media for tomato plant and source of some plant nutrients to tomato plants. This benefit amounted to US$ 452,945 of 243 ha floating gardens in eastern side of Inle Lake during one cropping season.

To this extent of study, off-site cost was underestimated because this study only includes costs of direct impacts of sedimentation, sediment trapping and sediment dredging. There are still indirect impacts such as cost of water quality control, cost of crop damage due to frequent flooding, cost of damage to the downstream irrigation system, cost of reduction in power generation and reduction in fish catch. In consideration of sedimentation only, off-site benefit can cover the off-site cost of sedimentation.

Off-site costs as yearly government expenditures to reduce the downstream damage point to the magnitude of the damage caused by erosion and sedimentation. The average annual cost of dredging sediments is more than the cost of trapping sediment in the stream before it enters into the lake. The irrigation department and policymakers for Inle Lake conservation might consider putting more resources in prevention of sedimentation of the lake rather than spending more in dredging the sediments out of the lake.

Keywords: Floating tomato garden, growing media, plant nutrients, sediment dredging, sediment trapping

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Accumulation and Binding of Human Pharmaceuticals in Wastewater Irrigated Fields in the Mezquital Valley, Mexico

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As a consequence of population growth and urbanisation, arable fields are increasingly irrigated with untreated wastewater worldwide. Wastewater irrigation is associated with risks arising from dissolved pharmaceutical residues, including the contamination of soils and crops as well as the proliferation and formation of antibiotic resistance. Environmental and health risks caused by pharmaceutical residues are profoundly affected by the compounds' binding and bio-availability in soils. The Mezquital Valley, located in the north of Mexico City, is one of the largest wastewater irrigation areas facing these risks.

We investigated the accumulation and sequestration of the antibiotics ciprofloxacin, enrofloxacin, sulfamethoxazole, trimethoprim, clarithromycin and the anticonvulsant carbamazepine in soils with different duration of wastewater irrigation (zero to 100 years). Sequential extractions with $CaCl_2$ solution and accelerated solvent extraction (ASE) were performed in order to determine an easy extractable ("bio-available") and a sequestered fraction of the compounds. The extracts were pre-concentrated via solid phase extraction (SPE) and quantified via LC-MS/MS. In contrast to our expectation no accumulation of ciprofloxacin, enrofloxacin, and clarithromycin were found. However, sulfamethoxazole and carbamazepine concentrations in the soils increased until a steady state was reached. Equilibrium between sorption, especially to the organic matter, and dissipation of sulfamethoxazole and carbamazepine seems to be reached.

Presently we are testing in batch sorption and desorption experiments whether the accumulation of organic matter in soils as a consequence of wastewater irrigation leads to an increasing binding and therefore decreasing extractability of the compounds over time. This process would lead to an inherent "mitigation" of the exposition of plants, animals, and humans to these pharmaceuticals in the wastewater irrigation area.

Keywords: Aging, carbamazepine, ciprofloxacin, clarithromycin, enrofloxacin, irrigation, soil, sulfamethoxazole, water re-use

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Monitoring of Endocrine Disruptors in Surface Water of Agro-ecosystems in the Mekong Delta, Vietnam

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Endocrine disruptors (EDs) are pollutant that may be hormonally active at low concentrations and are emerging as a major concern for water quality. Estrogenic EDs (e-EDs) are a subclass of EDs that can negatively affect humans and wildlife. We monitored the e-EDs in a peri-urban and a rural agro-ecosystem in the Mekong-Delta, Vietnam. The activity of e-EDs was analysed by the yeast estrogen screen (YES) assay and reported in terms of estrogenic equivalent activity (EEQ). Except in the canals (range: under the detection limit (ND) to 2.99 ng EEQ/L; median: 0.26 ng EEQ/L), the estrogenic activity in the agricultural fields (range: ND to 3.6 ng EEQ/L; median: 0.3 ng EEQ/L) and the fishponds (range: 0.05 to 2.66 ng EEQ/L; median: 0.69 ng EEQ/L) in Can Tho city (CTC) were significantly higher than those in their respective sampling categories in the more rural Dong Thap province (DTP), an upstream area of CTC. In DTP, the estrogenic activity ranged from ND to 2 ng EEQ/L (median: 0.19 ng EEQ/L) for the canals; 0.02 to 0.58 ng EEQ/L (median: 0.16 ng EEQ/L) for the agricultural fields and ND to 0.75 ng EEQ/L (median: 0.14 ng EEQ/L) for the fishponds. In total, about 14 % (in CTC) and 6 % (in DTP) of the samples exceeded the predicted no effect concentration (PNEC) of 1 ng EEQ/L, indicating a potential estrogenic risk to aquatic fauna in these sampling areas. However, this estrogenic risk is higher (*i.e.* the concentration and the occurrence frequency) at the downstream peri-urban area as compared to that of the upstream and more rural area. The direct discharge of domestic waste including human and animal wastes without properly treatment into surface water could be a major contributor to the observed estrogenic activity in the surface water of the Mekong Delta in Vietnam.

Keywords: Agroecosystems, endocrine disruptors, estrogenic activity, Mekong Delta

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Pesticide Residues in Soils and Sediments in the Mekong Delta, Vietnam

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Improper use of pesticides, as frequently reported to be prevalent in the Vietnamese Mekong Delta, can negatively affect the environment, human health and the economic return. Despite an increasing use of pesticides and raising concerns of the public for water quality and human health, no systematic monitoring of currently used pesticides has been put in place in the Delta yet. Concentrations of 13 different currently used pesticides were monitored at two representative study sites (An Long: rice monoculture, Ba Lang: mixed land use: vegetables, fruits and rice.) Samples were taken at both study sites in the wet and dry season in both, fields and irrigation canals. Pesticide analyses of the soil and sediment samples were conducted according to the method from Laabs et al. (1999). After extraction with acetone : ethyl acetate : water (2:2:1) ten of 13 pesticides were detected; concentrations ranged from 0,7 to 149 μg kg^{-1} DM. In average, sediments and soils from An Long showed higher detection frequencies and higher pesticide concentrations than those from Ba Lang which corresponds well with the more intensive agricultural setting at this study site (rice monoculture). Critical values for sediment and soil dwelling organism were exceeded by two pesticides (buprofezin and fipronil). The potential to set the groundwater quality at risk was evaluated as rather low. But the potential to pollute the surface water by particle bound transport and to harm aquatic and terrestrial animals or humans by bioaccumulation was estimated as high. This poses a threat for human health due to a direct consumption of very simple treated surface water as drinking water in the rural areas of the Delta. Furthermore, the consumption of animals reared on agricultural fields (wild capture or livestock-breeding within the main irrigation canals) as one of the main food sources leads to an endangerment of the resident population. As a consequence, an improved pesticide monitoring and the development of a sustainable water management are necessary in the Mekong Delta.

Keywords: Mekong Delta, pesticide residues, Vietnam

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Modelling the Effects of Changing Crop Patterns and Management Practices on N and P Loads to Surface and Groundwater in a Semi-humid Catchment (West Africa)

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Assessment studies of land and water degradation have developed from simple descriptions, based on monitoring and sampling to the analysis of multiple scenarios using simulation models. This increasingly involves the use of calibrated and validated simulation models to calculate soil nutrient losses as well as nitrogen and phosphorus fluxes to surface and groundwater system. Physical based models like SWAT as applied in this study are able to simulate the dynamic of soil nutrient pools at the field scale with various inputs: fertilisation, manure or residue application, fixation by symbiotic or non-symbiotic bacteria, and atmospheric fixation. In this work soil nitrogen and phosphorus pools are adjusted and local management practice considered to simulate water, sediment, and nutrient delivery to the stream flow at the Donga-Pont river catchment outlet (586 km^2) in the Republic of Benin (West Africa). At that scale crop patterns are not often mapped, leading to simplifications in the model application with the risk to cause a bias in the results. In this study, the available land use map derived from satellite image has been refined, allowing the evaluation of three modelling scenarios: Sc0 - agricultural lands were refined into 12 cropping systems with fertiliser supply only to cotton, rice and maize as common in Benin, Sc1 - assuming that all crops receive similar fertiliser input, and Sc2 - no refinement of land use map and no fertilisation were considered. Observed water yield, sediment yield and N load are well simulated in the scenario Sc0. Common simplifications (scenarios Sc1 and Sc2) lead to a distinct bias in the results. For reference scenario Sc0 considering a fertilisation rate (mineral N) of 30 kg ha^{-1} y^{-1}, nitrate loads to surface and ground-water were simulated as 53 tons y^{-1} and 738 tons y^{-1} respectively for the whole catchment. Silt and clay particle load sums up to 35,160 tons y^{-1} with an associated organic nitrogen load of 88 tons y^{-1}. Simulated land use and climate change effects for the year 2030 result in a decrease up to 20 % in sediment yield and an increase up to 50 % in related nitrogen load compared to the Sc0 scenario.

Keywords: Climate change, crop patterns, land degradation, land use, management practice, SWAT, water quality

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Water Use Characteristics of Cocoa and two Shade Tree Species in Different Production Systems

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Cocoa production in the humid tropics is practised by smallholders in different production systems ranging from full sun to shaded agroforestry systems under conventional and organic management. While the water use characteristics of cocoa trees (*Theobroma cocoa*) under dry conditions are well studied, little is known about the difference in the water use characteristics of cocoa in full sun versus shaded production systems and of shade trees in conventionally and organically managed agroforestry systems. Furthermore, there is a lack of knowledge regarding the impact of the management practices on the water availability for the cocoa trees in the dry season.

The objective of this study is to assess the influence of different production systems – organic and conventional, full sun and shaded – on the water use and availability of the cocoa trees, and to analyse and compare the water use characteristics of two shading tree species, Achiote (*Bixa orellana*) and Huasicucho (*Centrolobium ochroxylum*).

The measurements were conducted in experimental cocoa plantations in Alto Beni, Bolivia, during the transition period and in the dry season at a local cocoa variety and the two tree species Achiote and Huasicucho, widely used in cocoa agroforestry systems for soil fertility improvement, and additional products. The five studied treatments were: mono culture full sun conventional, mono culture full sun organic, agroforestry conventional, agroforestry organic, and successional agroforestry organic. The transpiration rate and the leaf water potential were measured with a steady state porometer and a scholander pressure chamber, respectively, and the obtained data evaluated by relating them to the potential evaporation of the research area, the humidity, evapotranspiration, and soil water content at the plots as well as the leaf temperature. The results of this study will allow a comparison of the water use characteristics of cocoa in different production systems. Furthermore, this study will lead to management recommendations regarding the selection of the appropriate shade tree species and the improvement of water availability for cocoa trees in the dry season.

Keywords: Achiote, agroforestry, *Bixa orellana*, *Centrolobium ochroxylum*, cocoa, Huasicucho, organic, shade trees, *Theobroma cocoa*, water use characteristics

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Production systems on the margin

Crop production systems

Yield Stability and Genotype × Environment Interactions of Upland Rice in Altitudinal Gradient in Madagascar

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Upland rice production has world-wide the largest potential for increasing area under production and thus contributing to food security in low-input farming systems. Upland rice is cultivated in tropical and sub-tropical rainfed environments in aerobic soils without impounding water. Production in high altitudes has been limited so far since the vegetation period in most cases does not allow growing rice due to its extended growth cycle. In addition, high altitudes are unfavourable as cold stress can induce pollen or spikelet sterility at anthesis. However, cold tolerant genotypes are capable to cope with this environment and can produce stable grain yield. According to climate change prediction, high-altitude environments will gain importance in upland rice production systems due to the expected positive effects such as rise in temperature and reducing sterility assuming that other climatic factors such as rainfall patterns will not have adverse effects. In order to evaluate the genetic variation in yield response across an altitudinal gradient experiments were conducted at three different altitude/temperature gradient locations with moderately water-limited conditions, ranging from hot-equatorial conditions to the lower limit of the crop's thermal adaptation in Madagascar for two years. 10 different and contrasting upland rice genotypes were sown at two monthly staggered sowing dates and meteorological data and site-specific soil characteristics were recorded. Genotype specific crop duration, tillering capacity, above ground biomass, grain yield and yield components, harvest index and spikelet sterility were monitored to identify specific traits for varietal adaptation. The result of yield stability and genotype-environment interaction will be discussed and presented.

Keywords: Cold tolerance, genotype-environment interaction, genotypic traits, upland rice, yield stability

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Testing Agro-ecological Adaptation and Participatory Acceptability of ten Herbaceous Legumes in South Kivu, DR Congo

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South Kivu Province in eastern Democratic Republic of the Congo experienced a long period of war and unrest that strongly affected agricultural production. After some time of relative calm, the region has now an increasing need to satisfy consumer demand for agricultural produce, including animal-based produce. Livestock is either reared in herds on natural grasslands or individually tethered to feed on spontaneous vegetation. Productivity is low, especially during the dry season. Using improved forages could play an important role to both enhance livestock production and improve soil fertility also preventing from soil erosion; however, research has been neglected in the recent past.

CIAT's Tropical Forages Program preselected ten herbaceous legume species and accessions that were previously evaluated under similar ecological conditions in tropical America and Southeast Asia. This research included *Canavalia brasiliensis* CIAT17009, *Centrosema molle* CIAT15160, *Clitoria ternatea* CIAT20692, *Macroptilium atropurpureum* cv. Siratro, cowpea (*Vigna unguiculata* IT95K52–34, IT97K1069–6 and IT98K131–2), *Lablab purpureus* CIAT-21603 and CIAT22759, and *Stylosanthes guianensis* CIAT11995, with *Desmodium uncinatum* cv. Silverleaf (as ILRI6765) for local check. Researcher-managed, small-plot agronomic evaluation took place on farmers' fields from November 2009 to January 2011 at higher (1600–1700 m asl.; Mulungu, Nyangezi) and lower sites (900–1100 m asl.; Kamanyola, Tubimbi), representative for agro-ecological conditions in South Kivu. After flowering started, plants were cut every 2 months up to four times. Differences of mean fresh leaf yield (MFLY) were established by ANOVA. Farmers' criteria and their selections were gathered during both rainy and dry season, ensuring gender equity in the groups at all four sites.

Across sites, stylo and Silverleaf desmodium produced the highest MFLY. Cowpea was not adapted anywhere showing low production, disease susceptibility and plant loss after the second cut. Differential plant adaptation occurred, *e.g.*, *Clitoria* being adapted only to Kamanyola, where MFLY was higher and different from the other three sites.

Farmers' selection criteria differed slightly among sites, but stronger so between rainy and dry season, emphasising overall biomass production with a preference for *Canavalia* and stylo. Uneven ranking of drought tolerance demonstrated how important the timing of participatory evaluation was. There was differential plant selection according to site.

Keywords: Agronomic evaluation, ecological adaptation, Kivu, participatory selection, smallholder, tropical forages

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Effect of Land Use Duration of the Agricultural Production of Lake Naivasha Wetland, Kenya

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Lake Naivasha is one of the fresh water lakes within the Kenyan part of the Great Rift Valley. In the last decades Lake Naivasha has been shrinking dramatically due to water abstraction. The sinking lake level is associated with an increase of the riparian land area. This newly uncovered land is being used for agricultural production by both small scale farmers for food crop production and by pastoralists as grazing land, leading to the emergence of chronosequences of land use. We hypothesise that the duration of land use differentially affects both the solid and the solution phase soil parameters, which in term influence the agricultural production.
Using the chronosequence as a model, we study the effect of land use duration on soil parameter changes, including spatial and temporal dynamics of water and nutrient availability. Furthermore we assess (1) maize yield potential and yield gaps and (2) forage productivity. We aim to derive threshold levels of resource based quality parameters in relation to land use duration.
Chronosequence positions of 30, 25, 20, 15 and 5 years were used to determine parameters relevant for agricultural production during the short and the long rainy seasons of 2010 / 2011. Soil moisture is being continuously monitored from 0–60 cm depth (TDR) and available soil nutrients (ion exchange resins) are determined. The biomass, species composition, palatability and digestibility of forage are assed in 400 m^2 exclosures at monthly intervals. Biomass, leaf area, nutrient uptake and grain yield of maize were determined along chronosequence adjacent to the forage study side. Preliminary findings indicate that with increasing land use duration, physical and chemical soil quality and soil moisture availability appear to decrease and this resource based degradation is reflected in declining forage yield and quality as well as in the yield potential of maize. Implications for sustainable use of the riparian land of Lake Naivasha will be discussed.

Keywords: Chronosequence, exclosures, ion exchange resins, TDR, yield gap

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Historical Development of Farming Systems Facing Increasing Saline Intrusion in Ben Tre Province, Mekong Delta

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Agricultural systems depend on different influencing environmental factors and are therefore in a regular need to adapt to changes in these factors. The need to enhance adaptation capacities is particularly important in rural areas facing intense climatic variations.

The delta of the Mekong River in the southern part of Vietnam is strongly characterised by agricultural production: 52 % of the total Vietnamese rice production (19.3 million tons) are produced in this area which is known as one of the most productive and intensively worked agricultural areas in Asia. Being at low elevation, the delta is also highly affected by salinity intrusion influenced by tides, particularly in the dry season when the flow from the Mekong River is at its lowest. While the freshwater supply in the rain season is abundant enough for rice cultivation, salt water intrusion from the sea increases salinity levels in dry seasons and affects the salt sensitive rice crop.

The variation in the salinity levels with increasing distance to the sea makes different adaptation strategies in the farming systems in the coastal and inland areas of the Mekong delta necessary to guarantee a stable and efficient agricultural production. Adaptation strategies include both technical infrastructure like dykes and gates to control saline intrusion, the cultivation of salt resistant rice cultivars or the shift to alternative farming systems such as integrated rice-shrimp farming. The aim of this research is to determine the development of changes and their mechanisms in the farming activities in Thanh Phu district during the past 30 years. The approach consisted in conducting 85 household surveys and two farmers' focus group discussions. Thanh Phu district is divided into three subregions according to the main farming systems: rice farming in the inland, rice-shrimp cultivation near the coast and shrimp in the coastal area. Farmers of all three subregions were interviewed to determine the influence of salinity on historical changes in the farming systems and their adaptation strategies. The importance of information campaigns and trainings provided by governmental institutions as well as by farmer associations and the results of the interviews will be presented.

Keywords: Adaptation strategies, focus group discussion, household interview, rural development

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Determinants of Farmers' Participation in Outgrower Schemes in the Biofuels Sector of Malawi

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The interest in large-scale commercial investments in Sub-Saharan Africa for food and bio-energy production has increased significantly in the recent past. Considerable debate has focussed on their chances and risks for rural development and poverty reduction. Outgrower schemes are a form of large-scale investments which are contractual partnerships between an agro-industrial company and small-scale producers. These schemes have often been claimed to be beneficial for rural development and poverty reduction as they provide farmers with access to finance, modern technologies, know-how, and markets. However, poverty reducing effects depend on whether poor farmers can participate directly in such investments or whether they lack the means to do so.

This paper seeks to address this issue by analysing determinants of farmers' participation in outgrower schemes in the sugarcane sector of Malawi. Sugarcane is produced commercially in Malawi since the 1960s and has strongly expanded since then. Since 1982, ethanol is being produced as a major by-product out of sugarcane. Its production targets the domestic petrol market, which has a 10 per cent ethanol blend. The sector is traditionally based on estates for sugarcane cultivation. In the recent past, however, land under smallholder production has increased considerably due to donor-funded large-scale smallholder-based irrigation schemes as a strategy to reduce rural poverty. As a result, outgrower schemes have evolved over time and increasingly integrate smallholders in the sugarcane sector.

This paper is based on a case study of commercial sugarcane production in Central Region of Malawi in Nkhotakota District. The analysis draws from primary data of around 500 randomly selected farm households. The data were collected during November and December 2010 in the vicinity of the Dwangwa sugar mill and ethanol factory close to Lake Malawi. Three main groups are covered in the sample: farmers producing sugarcane under rainfed conditions; farmers producing sugarcane on small plots in collectively managed irrigation schemes; and non-sugarcane growers in the same sugarcane producing region. The paper develops a multivariate logit model to identify the factors determining households' participation in rainfed and irrigated sugarcane schemes.

Keywords: Biofuels, Malawi, outgrower, participation, sugarcane

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Biogas as Business — Biogas Transport Technology and Economic Concept for Developing Countries

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Biogas dissemination in Africa addresses the aim of providing poor rural households with an affordable source of energy. The chosen approach, as defined in the countries' National Biogas Programs (NBP), is a highly subsidy-driven implementation of domestic biogas plants. Progress reports of several countries show a variety of discrepancies between goals and actual achievements. The currently implemented Ethiopian NBP is designed to provide 14.000 out of 11.2 million households in 4 selected regions within a 5 year period until 2013 with domestic biogas plants. Until December 2010 a number of 860 digesters had been installed. Major constraints of the NBPs are related to lacking financial attractiveness and to the conditions to be met by households: possession of at least 3–4 cattle to provide dung as input substrate, 350 to above 500 € as contribution to construction costs, water in reasonable distance. Thus, the majority of households is initially excluded from the programs by default. The aim of this study is to evaluate the potential of an alternative biogas dissemination concept. It is designed as business approach to make biogas more quickly accessible for a larger number of people. A mobile biogas storage container has been developed to facilitate the sale of biogas from a central, privately owned biogas plant The container is filled with biogas at the digester with up to 10 kPa by pressure equalisation between plant and container. It can easily be carried (3–4 kg) to the households and there connected to different appliances. Because all surrounding farmers can contribute to the biogas production by selling substrate to the plant owner, the full potential of biogas in a certain area can be exploited. The system provides easy and flexible access to biogas for theoretically every household with saving on training every user in biogas production. First field tests in rural Ethiopia approved the technology to be functional, easily accepted and understood by farmers. The further aim of this study is to determine economic data of the system "biogas as business" to be able to compile business plans for private investors und thus make biogas dissemination independent from subsidies.

Keywords: Biogas storage, biogas transport, business concept, developing countries

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Carbon Sequestration through *Jatropha curcas* Afforestation: Preliminary Results from Burkina Faso

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Afforestation with *Jatropha curcas* is often cited as promising option to alleviate energy scarcity through biofuel production and to fight land degradation by controlling soil erosion. *J. curcas* cultivation and processing in Burkina Faso has been actively promoted since 2007. The current study contributes to the ecological sustainability assessment of this growing sector. To this end, different scenarios of *J. curcas* production and processing in regard to their carbon and energy balances will be analysed. Based on a prior classification study of *J. curcas* systems in Burkina Faso, *J. curcas* systems were stratified in homogenous subgroups according to the criteria age, land management and region. Within these strata, 24 locations in four regions were selected for further analysis, comprising intercropping and monoculture systems up to an age of four years with different management intensities and living fences with an age up to thirty years. First results can be described with two foci: (1) plant-age, site and land management-dependent carbon sequestration in soil and biomass, (2) quantification of all on- farm carbon-based inputs.

By means of destructive biomass sampling, an empirical regression model predicting total aboveground biomass (B) with the stem diameter (D) could be developed, yielding $B=0.018\ D^{2.162}$ ($R^2=0.92$; $a=0.018\pm0.006$ ($p < 0.013$); $b=2.162\pm0.119$ ($p < 0.000$)). Depending on site and management properties, the aboveground biomass production varies strongly with the lowest biomass production observed on afforested marginal sites. A 2.5- year-old not managed *J. curcas* plantation on marginal land (Leptosol), characterised by shallow stony soil on a steep slope, accumulated 174.5 ± 132.3 kg of dry aboveground biomass ha^{-1}, providing no seed yield. In contrast, a 2.5-year-old plantation on a Lixisol managed by regular weeding and low fertilisation in the same region, produced 796.6 ± 303.5 kg ha^{-1} with a dry seed yield of 704.4 ± 166.2 kg ha^{-1} a^{-1} ($p < 0.005$) (both planted in a planting distance of 4×4 m). The same trends show below-ground biomass. Overall investigated systems, aboveground carbon stocks ranged from less than one Mg C ha^{-1} for young plantations to 15 Mg C ha^{-1} for mature living fences.

Keywords: Biofuel, Burkina Faso, carbon sequestration, Jatropha

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Assessment of *Jatropha curcas* Systems and their Potential for Rural Development in Burkina Faso, West Africa

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Jatropha curcas (JC) is a non-edible, perennial, multipurpose plant with many positive attributes and considerable potentials. The seeds have high oil content (*e.g.* for biodiesel or as fuel for kitchen stoves) and it can be used to reclaim land as a hedge or commercial crop. JC is said to be a fast growing and drought tolerant plant, even growing on soils where nothing else survives, and therefore not compromising food security. Thus cultivation of JC could provide employment, improve the environment and enhance the quality of rural life. Moreover, JC could provide resource-poor countries with a means to invest in their own rural areas instead of spending their capital to purchase fossil fuel.

The research revealed the current status of JC systems and its potential for rural development in 6 regions of Burkina Faso. Randomly selected JC systems in different agro-ecological-zones were investigated by using semi-structured interviews, focus group discussions and direct observation in the field. A total of 180 farmers participated, named preferable characteristics for their JC, explained Jatropha's advantage and contribution to their livelihood and environment, and stated their experiences and main obstacles in JC production. The research identified two central JC systems in Burkina Faso, plantation and hedge systems and highlights differences among and between them regarding: (a) Basic information, (b) Management, (c) Utilisation, (d) Land use (change) and (e) Soil characteristics. Moreover it determined risk and sustainability points in JC production, in order to elaborate site-specific recommendations. There is only a limited understanding on the impact of different systems and management factors regarding yield structure of JC hence measurements were done in the two systems to reveal differences and correlations among the systems and yield structure factors.

The multipurpose use of JC, benefiting economic, environmental and social development, should be further improved by considering traits of local importance. To use the full potential of JC and to support further development and systematic selection, breeding and domestication are required. Altogether, the research assisted to systematically investigate JC systems in Burkina, in order to support sustainable production. Thus it can contribute to rural development and livelihood improvement of JC producers in Burkina Faso.

Keywords: Biodiesel, Burkina Faso, food security, *Jatropha curcas*, poverty alleviation, rural development

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Sub-Saharan Africa's Role in International Biofuel Trade

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Producing and exporting raw material for biodiesel like canola oil, palm oil or others, is an opportunity for many agriculturally dependent developing countries. Although they should have a comparative advantage in these goods, they do not export as much as would be expected. Especially sub-Saharan countries claim to be disadvantaged in the international trade of biofuels in terms of exporting raw products and the final biofuel to developed countries. Indeed, canola oil, the most important pre-product for biodiesel in Europe, is even mainly grown in industrialised countries.
This paper analyses the role of tariffs and other barriers in explaining trade patterns generally and the lack of trade in certain goods in particular. The reason for the small involvement of sub-Saharan African countries is of special relevance here.
Moreover, we will take a closer look at how the value chain is split up and analyse the effect of demand for bioenergy and supply of raw material on production patterns. An especially important topic to analyse in this respect is the decision which parts of a value chain to keep close to the production of raw material. This decision for or against fragmentation of the value chain is influenced by transport and production costs. They play a major role here and are taken into account in our model.
To control for period specific effects like the announcement or introduction of political measures concerning bioenergy, we use a set of panel data reaching from 2005 to 2009. The underlying model is a gravity model, since it is best suited to analyse bilateral trade flows. We allow for a zero inflated trade variable in the gravity equation to capture effects of potential bilateral trade relationships. A two stage estimator is applied to counter the resulting selection bias and spatial weights are introduced to control for spatial autocorrelation.

Keywords: Africa, biodiesel, biofuel, canola, gravity model, Heckman, value chain

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Determinants of Household Fuel Use and Options for Fuel Switching in Rural Western Kenya

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Biomass has remained the dominant source of energy used by most rural households in the developing world. Current use patterns have been linked to adverse effects on forest resources. Alternative fuels such as kerosene could mitigate these negative effects. In order to design policies that enhance the use of alternative fuels a first step is to understand the determinants of fuel quantity and fuel types. This is crucial for informing forest conservation policy without making local households worse off. This research looks into the factors that determine the use of energy by rural households living next to a common property resource. Empirical results are based on a quantitative study of 286 households randomly selected from the community living in villages within 5 km from the edge of Kakamega forest in western Kenya. The data collected include details of the quantities and values of different energy types used as well as household and demographic attributes. A demand system for household energy use is estimated using a two stage LES-AIDS model. Results show that household income is an important, but not the only determining factor for the type and level of fuel consumption. The household size, public forest governance rules and prices of different fuel types also play an essential role. The results of this study confirm biomass fuels are used alongside modern fuels without displacing them, evidence of fuel stacking as opposed to fuel switching, a phenomenon also observed in urban households. The public forest is an important source of biomass fuel supplying firewood to 50 % and charcoal to 15 % of sampled households. The consumption of kerosene tends to increase with the price of charcoal, suggesting potential for a change to a more forest conserving fuel with increasing scarcity of charcoal. A price instrument coupled with effective institution for forest management can enhance the conservation of the common pool forest.

Keywords: Fuel demand, fuel switching, Kakamega forest, LES- AIDS

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Life Cycle Assessment on the Substitution of Dung Combustion by Biogas Systems in Ethiopia

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The utilisation of dried dung cakes as a fuel for household cooking stoves is very common in rural areas of developing countries. The greenhouse gases thereby emitted contribute to the global warming potential (GWP) and endanger the human health of the local people. In industrialised countries, biogas production by anaerobic digestion is assessed as an efficient way to reduce greenhouse gas emissions from dung management and to preserve nutrients for plant production.
The objective of this study was to assess the environmental impacts of biogas systems used for the provision of cooking heat in rural areas of Ethiopia. Two scenarios for the provision of thermal household energy were taken into consideration. The first one describes the situation at present, where cattle dung was dried and used in household cooking stoves. The second scenario was the usage of the fresh dung as a substrate for anaerobic digestion to produce biogas and combustion in a biogas stove.
The method of Life Cycle Assessment was used according to the ISO 14040 and 14044 standards. A model was built with the GaBi-software and system expansion was used to deal with additional functions of the system. The life cycle inventory was based on literature values *e.g.* for emissions of dung cake combustion, methane losses of the biogas plants and methane conversion factors. Impact assessment was done using the CML 2001 method in the version of 2007 for the impact categories GWP, acidification potential, eutrophication potential and human toxicity potential (HTP).
The production of biogas leads to several environmental advantages compared to the dung combustion system. The results indicate that the GWP can be reduced about 1.36 kg CO_2 equivalents MJ^{-1} heat delivered to pot. The fertiliser value is increased due to a higher nitrogen content of the biogas plants effluent compared with the ash of dung combustion. Furthermore, emergence of cooking smoke in households is reduced considerably which results in a saving of 32 g DCB equivalents MJ^{-1} heat delivered to pot concerning HTP.

Keywords: Biogas, dung combustion, eastern Africa, Ethiopia, LCA

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Biofuel from Forestry: Promising or Disappointing? The Case of Jatropha in China

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Over the last decades, interest in Jatropha considerably increased as a promising tree for biodiesel production from non-arable land. Therefore, Jatropha has been promoted in many places like India, Africa and China. China represents an interesting case due to its political goal of maintaining food self-sufficiency, a steeply increasing demand for energy and a ban on biofuel production on arable land. The plantation of Jatropha on marginal lands has been one strategy to combine political goals and increasing energy demands. It not only supplies energy but contributes to income generation in remote areas and bears further benefits like decreasing soil erosion. The government initiated the plantation of Jatropha in the framework of a project called Forestry Oil Integration (FOI) scheme, a cooperation between state-owned energy companies and the State Forestry Administration. The aim of this research is the identification of factors for the success of government initiated energy forest projects on marginal land. Case study research was carried out in 2010 in two Chinese provinces, Sichuan and Guangxi, including stakeholder interviews at different levels.
The result of the survey is unexpected: All plantations in the survey area stopped. We identify three main factors for the failure: institutional factors, geographical factors and market risks. First of all, within the FOI scheme, governmental programs are combined and alliances with non-governmental actors are undertaken in a way that is not resilient to external shocks. The project failed in establishing sound institutions to prevent a complete failure due to external shocks. The interests of the local government and farmers seem to above all relate to the subsidies within the scheme, which is why the plantation stopped quickly after the termination of the subsidy flow. On the other hand, on marginal land, Jatropha is low in productivity and economic return, as well as very sensitive to frost. Finally, the sudden decrease of the market petroleum price in 2008 cooled down the promotion of Jatropha. The findings from the FOI project illustrate setting sound institutions capable to deal with external risks is required, which contribute to refining the previous study of Jatropha.

Keywords: Biofuels, China, farmers' adoption, institutions, jatropha, marginal land

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Rural Energy Patterns and Fuelwood Demand of Mengsong Administrative Village, Xishuangbanna Prefecture, Yunnan, China

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An estimated three billion people from developing countries worldwide rely primarily on biomass such as fuelwood and coal as energy sources for household consumption. In China, biofuels account for 70 % of rural energy consumption, of which 14.60 % is provided by fuelwood. In the mountainous regions of Xishuangbanna Prefecture, Yunnan Province China, the traditional processing of tea is of increasing importance as a driver of fuelwood consumption besides household consumption and the heating of pig feed for domestic hog feeding.

This case study is an attempt to estimate the fuelwood demand of Mengsong Administrative Village, Xishuangbanna Prefecture, and to explore the drivers for fuelwood demand as well as the importance of regenerative energies. For this purpose, Mengsong Administrative Village was stratified into three strata according to dominant land use, road and market access, and elevation. One village was selected at random in each stratum and studied through the application of qualitative participatory methods and semi-structured questionnaires, and by the weighing of firewood.

The study estimates the total annual fuelwood demand to be 3.903 t for 606 households. The main share of this amount is used for household consumption (72.11 %), pig feed preparation (15.22 %) and tea roasting (12.67 %). Differences were found to exist between villages with respect to the quantities of firewood used for tea roasting and pig feed heating. Villages with the lowest market and road access, and the highest degree of self-sufficiency in food production have the highest demand for firewood to be used for cooking pig feed as well as for the roasting of tea, which is the most important source of income in these villages. Fuelwood saving devices, such as solar heating systems and improved efficiency tea ovens have been widely adapted through villagers' own initiative.

To conclude, fuelwood is the major energy source in Mengsong Administrative Village, and is unlikely to lose its importance in ensuing years mainly on account of entrenched customs, scarcity of income sources, and a high degree of self-sufficiency. Villager initiatives to reduce the amount of combusted fuelwood could, however, be further enhanced with government support.

Keywords: *Camellia sinensis*, China, fuelwood, rural energy demand, stratification, Yunnan

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Improving Household Energy Systems in Rural Ethiopia: A Comparative Study of Traditional Energy Sources and Biogas

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Traditional biomass like fire wood, crop residues and cow dung are still the main energy sources in rural areas of developing countries. Due to environmental and health issues an alternative energy management system has to be found, with an energy source being energy-effective and cost-efficient at the same time. Biogas, as renewable energy, gets highly promoted recently in developing countries.

In this context, the potential of wood, cow dung, biogas and biogas digestate as energy source was investigated and compared in terms of energy and fertiliser values as well as economic efficiency in rural Ethiopia. Fuel samples were taken at different rural households and fixed dome biogas plants with a volume of 4 to 12 m^3. Dried samples were analysed for combustion characteristics, namely calorific value, volatile matter and ash content. Further, standard water boiling tests were performed on local stoves for wood and dung cake and the widely distributed Cambodian biogas stove. We also analysed fertiliser values of the different fuels and ash remaining from cooking with fire wood.

Cow dung and biogas digestate show similar combustion characteristics. However, their energy value proved much lower than those of biogas. Field tests showed that dung as single fuel for cooking was not sufficient for the preparation of meals. Fertiliser values are generally higher for ash than for dung and digestate which contain similar nutrient levels,

At the observed energy values, biogas proves to be economically more efficient than other fuels, in particular wood or dung. Moreover, energy from biogas provides synergies between cropping and livestock systems through saving agricultural labour for wood collection and providing fertiliser from slurry.

Keywords: Biogas, dung, energy source, fertiliser

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Biodiesel Production from *Jatropha curcas* L. in Mexico: From Governmental Promotion to Peasant Adoption

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Jatropha curcas L. has been highlighted as a possible source of biodiesel production in many areas around the world. It is stated that its production improves socio-economic development of rural areas and that it is also useful to recover marginal and degraded lands. Furthermore, it is assumed to have little competition with food production and small negative effects on environmental services. For these reasons many policy makers, investors and NGOs are interested in tackled energy supply, emission reduction and rural development by cultivating Jatropha. However, socio-economic sustainability of the cultivation of *Jatropha curcas* L. for biodiesel production has been sparsely analysed. The present study analyses the promotion initiatives that are taking place in Chiapas State, Mexico, at different stages of the Jatropha production chain (cultivation, production or usage). Data were obtained through qualitative research methods, including literature review, interviews with key stakeholders, focus group discussions, farmer interviews, structured questionnaires and field observations. Our results show that governmental policies are not completely coordinated with farmer needs. Jatropha promotion by the state government aims to transform "unproductive" land into Jatropha, but production capacities or the agro-ecological potential of the area have not been taken into account. Additionally, extension agents did not have complete knowledge about the cultivation of the tree or the rules concerning promotion programs, generating reluctance to plant and confusion among farmers. Moreover, it seems that smallholders did not plant on forest areas but they planted Jatropha on lands where edible crops such as maize, beans or peanuts had been grown.

Keywords: Adoption, biodiesel, *Jatropha curcas*, land use conversion, socioeconomic impact

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Energy Potential of Excrement Biomass of Selected Domestic Animal Species

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This paper summarises a research that was conducted in the Indian Himalayas, Zanskar Range, during the summer 2009. The subsequent experiments on the biomass fuel properties were carried out in the Czech Republic.
In order to acquire data on the dung-as-a-fuel usage, one of the most remote villages in Indian Himalayas was visited. The inhabitants were asked questions related to the resource of heat energy that is widely utilised here – the dried excrements of domestic animals. The focus was on the techniques of collection, storage and on the qualities of the different types of dung used. The amounts of dung burned daily were measured as well. The data obtained were used to estimate the total amount of dung used per capita per year. Supposing the energetic value and the efficiency of energy transformation to its usable form, the total amount of energy needs for cooking and heating may be quantified.
A few samples of different types of dung were brought to the Czech Republic in order to conduct experiments including fuel properties and biogas production analysis. The different types of dung were divided into 3 groups according to the taxonomic group of animal. Samples of dung were collected in the Czech zoos as well. The results of the fuel properties analysis (calorific value, volatile combustible matter, ash properties, element analysis) will be presented, as well as the results of biogas production potential
The direct measurements showed that the daily fuel consumption during summertime of a wealthy family to be 11,29 kg on average, that is 1,13 kg per capita per day. The average family consumes 6,93 per kg per day, that is 1,38 per kg per capita per day. The average all year-round fuel and heat energy consumption was enumerated as $3{,}87 \pm 1{,}35$ kg per capita per day and $12{,}24 \pm 4{,}3$ MJ per capita per day, respectively. The fuel dung calorific value ranges from 11,08 MJ kg^{-1} to 16,29 MJ kg^{-1} depending on the origin and "type" of the dung examined. The biogas potential seems to be the greatest for the family equidae.

Keywords: Biogas, biomass combustion, energy needs, fuel dung, yak dung

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Economic Assessments of Cashew Production for the Promoting of the Competitiveness of African Cashew Farmers

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Cashew is a major cash tree crop in Africa with approximately 40 % of worldwide production of raw nuts (848,000 metric tons in 2010). The majority of about 2.5 millions small farmers struggle to make as little as € 90 to € 330 per year through the production of cashews. Such low incomes result from a number of factors, including growing the trees on marginal land (low productivity), poor quality nuts and a lack of technical and business skills.

The African Cashew initiative, a public-private partnership, started 2009 to strengthen the competitiveness of cashew production and processing in Africa and to assist small scale farmers to increase their productivity.

Technical feasibility related to the management capacities of the farmers in combination with expected economic benefits and risks related to the proposed innovations determine adoption behaviour of farmers.

Trainings on good agricultural practices (GAP), including intercropping as well as integrated pest and disease management have been conducted in major cashew growing zones of five African countries.

Economic assessments of cashew production systems were established on the basis of collected data and interviews with resource persons using a standard spread sheet format provided by GIZ's Sustainable Cocoa Business programme. The major findings and recommendations of this study are:

1. Intercropping is a key factor for the profitability of the business. It allows higher incomes during the first years where the trees are not fruiting yet. It is therefore recommended to associate intercrops, respecting good agricultural practices, during the first six years after plantation. In general cashew production is not very capital intensive and thus valuable for small scale farmers. The combination of GAP applied in plantations established from improved (grafted) seedlings provides the highest benefit and is 8 times more profitable than the current "farmer's practices" in West Africa.

2. As long as sufficient grafted seedlings are not available, using improved seeds is recommended. However, according to the location the potentially lower yield as major factor for improved productivity and hence benefit has to be assessed as maintenance costs for applying GAP remain and a low maintenance system would eventually be equally profitable.

Keywords: Cashew productivity, economic assessment, marginal land, west africa

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Adoption and Farm-level Impacts of Zero Tillage Wheat in Haryana, India

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There has been an increased scientific interest in developing agricultural technologies that are resource conserving, environmentally sustainable, while ensuring financial profit to the farmers. Most prominent of such resource-conserving-technologies in the cereal system of South Asia is the zero tillage (ZT) wheat. The present study aims to assess the adoption pattern and farm impacts of ZT wheat production in the state of Haryana, where farmer adoption of the technology is found highest in India. A farm-household survey, covering 180 farmers, including full adopters, partial adopters and non-adopters of the ZT technology, contributed to the database. Determinants of adoption were attempted employing a multinomial logit model that indicated significance of ZT machine (drill) ownership, cropping pattern, and household and regional factors influencing ZT adoption.

The literature survey indicates that the most pronounced impact of ZT is at the cost-saving compartment. However, since ZT wheat farmers could sow the crop much earlier than their conventional counterparts, and early sowing is associated with higher wheat yield, a significant and positive yield impact is also expected. The paper shows that, mainly by avoiding land preparation, cost of cultivation was decreased by 35 per cent in 2009–10 crop. As the yield was also increased (by 8 per cent), a significantly high benefit-cost ratio of ZT (2.54, in comparison with 2.05 of conventional farming) is generated, indicating the financial viability of the technology. Despite this, there exists a number of constraints for continuous adoption of ZT, including uncongenial field situation (excess moisture, undulated plots, small landholding etc.), and difficulty to manage previous/kharif crop (pearl millet, cotton, rice) residues. Since this technology is also effective in reducing the farmer dependency on external inputs and ensures sustainable production of wheat, acreage under ZT should be further expanded, possibly through innovations that facilitate ZT operation in the adverse plot scenarios, especially in the cotton-wheat and pearl millet-wheat cropping systems. The recent ZT technological advancements in NW India, viz. Turbo Seeder, that overcome many of the aforementioned constraints are also discussed in the paper.

Keywords: Impact assessment, India, resource conservation, technology adoption, zero tillage

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Causes of Variability in Climbing Bean Farming Systems Across Different Farm Types in Northern Rwanda

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N2AFRICA is a development and research project focused on putting nitrogen fixation to work for smallholder farmers growing legume crops in Africa. Within this project, farming systems in northern Rwanda were characterised with focus on the role of climbing beans (*Phaseolus vulgaris* L.). Data was collected on resource flows, soil properties, crop productivity, field management and biological nitrogen fixation (BNF) and on farmers assessment of production constraints. Farmers were classified according to regional specific resource endowment indicators, following the governmental household typology 'Ubudehe'. Large variations in soil fertility, productivity and BNF were observed within and between farms. While landscape had a clear effect on soil organic C, total N and sand content, individual management factors were not correlated to soil fertility. Fields were all managed intensively due to land scarcity and high population density (524 people km^{-2}), and there were no clear effects of management or field distance from the homesteads on soil fertility. However, the density and height of stakes used as support for climbing beans correlated well with yield. Resource-poor farmers had less access to quality stakes and achieved smaller mean grain yields of 1.45 Mg ha^{-1} than wealthier farmers who harvested 2.22 Mg ha^{-1}. BNF measured with the natural abundance method was relatively low with on average 50 % N derived from the atmosphere and 93 kg N ha^{-1} fixed in all above- and below-ground plant parts. Depending on farmers' bean residue management, N-budgets per field ranged from -80 to 45 kg N ha^{-1} neglecting N returned to fields in animal manure after feeding bean residues. Resource-poor farmers, who all fed bean residues to animals, had an average negative N-budget of -43 kg N ha^{-1}. Wealthier farmers, who retained part of the residues on fields, had an average N budget of -3 kg N ha^{-1}. The study highlights the complexity of smallholder farming systems in East/Central Africa. Further, it shows that the 'Ubudehe' farm typology is useful to explain variations in resource use and productivity and is a potential tool for tailoring extension and technology services to the needs of farmers.

Keywords: Biological nitrogen fixation (BNF), climbing beans, farm typology, farming systems, N-budgets, N2AFRICA, *Phaseolus vulgaris* , Rwanda, Ubudehe

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CA2Africa: Conservation Agriculture in Africa: Analysing and Foreseeing its Impact – Comprehending its Adoption

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Conservation Agriculture (CA) is increasingly promoted in Africa as an alternative for coping with the need to increase food production on the basis of more sustainable farming practices. CA is specifically seen as a way to address the problems of soil degradation resulting from agricultural practices that deplete the organic matter and nutrient content of the soil. It aims at higher crop yields and lower production costs. Yet, success with adopting CA on farms in Africa has been limited.

'Conservation Agriculture to Africa' (CA2Africa) is a European Commission-funded project (www. ca2africa.eu) seeking to understand why CA techniques have not been adopted widely throughout Africa. The objective of the project is to examine the agronomic, agro-ecological, socio-economic and institutional conditions that determine success or failure of CA. It brings together the major research players involved with CA in Africa to share, assess and learn together with practitioners from past and ongoing experiences on CA in five regions across Africa on the basis of selected case studies: Eastern Africa (Kenya/Tanzania); Southern Africa (Zimbabwe/Malawi/Zambia); Western Africa (Burkina-Faso/Benin); Northern Africa (Morocco/Tunisia) and Madagascar.

CA is analysed and understood using a conceptual framework that distinguishes three

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scales of analysis: field, farm/village and regional scale. The relative importance of the different determinants of adoption operating at each scale is determined for each case study and guides the assessments and type of analysis.
From a biophysical, technical point of view, crop/soil models are used to assess the performance of CA at field scale. At farm and village scales, trade-offs in the allocation of resources become important in determining how CA may fit into a given agro-ecosystem. Trade-off analysis is done using bio-economic household models. At a regional scale, a qualitative expert assessment tool kit has been developed to determine the specific regional socio-economic, cultural and institutional settings that determine adoption of CA.
This contribution will present the overall project philosophy, its conceptual and methodological approaches as well as results from testing selected modelling tools for selected case studies across Africa. These results show the importance of different driving forces and inhibiting forces for CA adoption.

Keywords: Adoption studies, bio-economic modelling, biophysical modelling, conservation agriculture, innovation systems

Sustainability Assessment of peri-Urban Vegetable Cultivation Systems in the Red River Delta, Vietnam

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Urbanisation and industrialisation in many parts of the world leads to rapid changing environmental conditions along urban-rural interfaces. This makes direct impact people who are involved in urban or peri-urban agriculture. These trends are particularly evident in Vietnam, where became larger the concerns about the risk of contamination of waters, soils and agricultural products due to heavy, or inappropriate use of fertilisers, pesticides, and poor quality irrigation water. The case studies were conducted in three selected communes in peri-urban areas of Thanh Tri district in Hanoi in Red River Delta, Vietnam. The farms in these communes are small-scale vegetable and/or mixed vegetable-rice farms, using high inputs of soil amendments and pesticides for diversified cropping systems. The agricultural land and vegetable area in the study area had significant changed from 2000 to 2009. The agricultural land decreased by 36.7 % (3815 ha in 2000 with 2416 ha in 2009 in comparison). The vegetable area in 2009 was 1027 ha, decreased by 549 ha (34.8 %) compared with the year 2000. The agricultural used land has changed to other land use types, *e.g.* for residences, business, and public works. Following the investigations a small number of vegetable species is cultivated in the study area, *e.g.* indigenous vegetables as cucumber, leafy cabbage, yard long bean and water morning glory and non-indigenous vegetables as headed cabbage, cauliflower, kohlrabi and tomato. The average of farm size was 0.152 ha in which 0.1 ha for vegetable production, the number of plot was 5.7 and plot size was 0.027 ha. The sustainability assessment by multi-criteria evaluation was done with the weight factors were estimated by pair-wise comparison method based on twelve indicators. The aggregate value for environmental sustainability indicators was 0.42, the social sustainability indicator was lowest (0.37), and economic sustainability was highest (0.74). The overall sustainability of vegetable cultivation systems in the study area was conditional sustainability (0.52).

Keywords: Multi-criteria evaluation, Red River Delta Vietnam, sustainability assessment, vegetable

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Agronomic Performance and Nutrient Composition of *Andropogon tectorum* as Influenced by Varied Inter-row Spacing of *Lablab purpureus* during a Minor Wet Season in the Derived Savannah Zone of Nigeria

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The project examines the effect of interplanting *Lablab purpureus* at 0.0 m (control), 2.5 m, 5 m and 7.5 m inter row spacing on agronomic performance and nutrient composition of *Andropogon tectorum* during a minor wet season in the derived savannah zone of Nigeria. Though the highest numerical plant height value of 274 cm was observed on the 2.5 m *Lablab purpureus* spacing, it was similar to values obtained at 5.0 and 7.5 m (268 cm and 266 cm respectively) but significantly different ($p < 0.05$) from the control treatment (230 cm). Also the longest leaf length was observed at the inter-row spacing of 2.5 m which was significantly different from other inter-row spacing. The highest *Andropogon tectorum* biomass value of 18,400 kg ha $^{-1}$ was obtained at 2.5 m legume inter-row spacing and the lowest value of 9,800 kg ha $^{-1}$ for the control. The dry matter contents of the forage were significantly different from each other ($p < 0.05$) except with 5.0 m and 7.5 m legume inter-row spacing. Crude fibre that was observed to be highest at the sole *Andropogon tectorum* control stands (31.20 %) and decreasing with decrease in legume inter row spacing, with the least value (27.20 %) obtained in the 2.5 m legume inter-row spacing. Closer legume inter-row spacing had a positive influence ($p < 0.05$) on the nutrient content of *Andropogon tectorum*. Though Zn concentration in sole *Andropogon tectorum* stand was highest (15.80 mg kg^{-1}) and it decreases with decreasing legume inter-row spacing, the Na, Ca, K, P, Mg Fe and Cu contents of *Andropogon tectorum* were observed to be decreasing with an increasing inter-row spacing of the legume.

Keywords: *Andropogon tectorum*, inter-row spacing, *Lablab purpureus*

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Assessing Impacts of Farmers' Land Use Change Decisions on Long Term Soil Fertility in North West Vietnam Using a Reverse Modelling Approach

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During the last two decades, farmers in Son La province, North West Vietnam, have reduced and finally omitted fallow periods when replacing the traditional swidden system with intensive maize monocropping. Land use in upland areas has been in a transition from upland rice, cassava and local maize varieties as staple crops towards hybrid fodder maize as cash crop. Despite higher expenses for seeds, synthetic fertiliser, pesticides and draft power, a hybrid maize boom has been observed in the region since 2007, which can be explained by the high productivity, revenues and direct cash income related to this crop. At the same time farmers are aware that intensification is not sustainable and soils are heavily degraded, mainly through water erosion when cultivating on steep slopes.

The study assesses impact of land use and management on soil fertility during 20 years under known land use change using a landscape model. Based on field information on land use, history trends of soil fertility are reconstructed in the simulations and model outcomes are validated against recent field measurements of soil fertility related parameters.

Aerial photos (1954, 1999) and satellite imagery (1999, 2007, 2010) were used to create land use maps using visual interpretation and supervised classification, past ground truth points supplemented by transect walks and key person interviews. More detailed information on cropping history and farmers' decisions were obtained from semi-structured household interviews and focus group discussions. Soil samples were collected along transects that reflect expansion of cultivation areas over time. Soil carbon, texture, available N and P were analysed and used for validation of the LUCIA (Land Use Change Impact Assessment) model.

Results of this study will serve as model validation and a basis to assess alternative land use options. Assessment of soil fertility changes under land use change will support land development agencies at local and national level when planning sustainable development in the area under current challenges, *e.g.* the rubber boom. In a second instance, data on land use history and farmers' decisions will be used to develop a decision-making module for the LUCIA model .

Keywords: Farmers' decisions, LUCIA, maize, soil fertility, Vietnam

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The Response of *Musa* Cultivar Root Systems to a Tree Shade Gradient

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Commonly bananas and plantains are grown in mixed agroforestry systems by small farmers for home consumptions and national markets. Throughout Latin America, *Musa* cultivars are grown in association with shade-grown coffee. The cultivar Gros Michel (AAA) is widely planted, although farmers also grow many other cultivars. A research project funded by GIZ through Bioversity International in collaboration with national research organisations and German universities aims to identify approaches to improve farmers returns both in terms of production and income.

In fulfilment of objectives to understand the partitioning of light, water and nutrients in this multi-strata agroforestry system, amongst others, the study of root distribution and aerial biomass in four *Musa* cultivars established in coffee fields with minimal, 25 %, 50 %, 75 % shade of *Erythrina poeppigiana*. Data (roots >1mm diameter) were collected in three replications for each cultivar and shade level with four monoliths (18,000 cm^3). One cultivar was sampled with 20 small samples using a root auger (567.5 cm^3) at 0.4 m, 0.8 m (0–20 cm deep) and 1.2 m (0–10 cm deep) from the pseudostem. Total root biomass was estimated using auger method and transferring it to other cultivar‘s monolith method.

The plantain Curraré (AAB) and the cooking banana Pelipita (ABB) had higher values for root variables (dry biomass per unit of soil, volume) than Gros Michel and Red (AAA). For all cultivars, except Gros Michel, root dry biomass was highest in 25 % shade, followed by minimal shade with the lowest values for 50 and 75 % shade. The total banana root dry biomass was >1 kg for 25 % shade, 0.2–0.4 kg for minimal and 50 % shade, whereas 75 % shade had <0.2 kg, while no significantly different abundances of other roots occurred. Banana root biomass was reduced less than above-ground biomass for moderate levels of shade with a decline in shoot-root ratios, although ratios increase for >50 % (Red, Pelipita) and >75 % (Gros Michel, Curraré) again. The studies‘ results do not indicate whether differences are due to light reduction or increased root competition, but tree and coffee roots were not significantly more under increasing shade.

Keywords: Agroforestry, banana, Costa Rica, Curraré, Gros Michel, *Musa*, Pelipita, roots, shade trees

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Nutrient Manager for Rice (NMRice): The Development of an ICT-based Tool for Site-specific Nutrient Management of Lowland Rice in West Africa

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Available blanket fertiliser recommendations for major rice growing domains across Africa are often not affordable for rice growers contributing to the low fertiliser use in Africa of only 8 kg per hectare. Hence, the need to develop a site-specific nutrient management (SSNM) tool for small-scale rice farmers that takes into account the wide range of crop management practices, soil heterogeneity, and varying access to fertilisers and the needed capital to purchase them. Based on the scientific principles of 15 years of SSNM research across Asia and Africa, we are in the process of developing a tool that allows rice farmers the precision management of their fields. The aim is to increase farmers' profits by 100 US$ per hectare and season. The NMRice tool is currently developed for irrigated and favourable rainfed lowland rice systems in the Senegal River Delta and Valley, the Office du Niger and the Sikasso Region in Mali, and rice growing areas in the North of Ghana and Nigeria. The development process comprises the following steps: (1) Collection of omission plot data and the determination of fertiliser responses to calibrate the underlying model for given rice domains; (2) Development of domain-specific questionnaires to acquire the necessary information to compute the field-specific nutrient needs based on 15 to 20 simple questions about the field; (3) Programming of country- or domain-specific software versions of NMRice and the small-scale evaluationof the NMRice recommendation compared to the farmer's practice; (4) Development of ICT applications for the calculation of field-specific recommendations that quickly reach rice growers and extension workers followed by large scale-testing. The ICT applications include a web application for extension services with internet access, an android app for smartphones for use by extension and community knowledge workers directly in the field, as well as a mobile-phone based application using interactive voice response that can be directly used by farmers when internet access is not available. Acknowledging the need of small-scale rice growers for field-specific crop management guidelines in addition to fertiliser recommendations, we plan to advance NMRice into a crop management tool in the near future.

Keywords: Android application, field specific fertiliser recommendation, interactive voice response, mobile phone application, rice, site-specific nutrient management

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Lowland Rice Growth and Productivity as Related to Landscape Position, Bunding and Fertiliser Application

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Rainfed lowlands present a high potential for rice production in West Africa. The exploitation of marginal areas such as inland valleys was examined to evaluate the potential for the expansion of lowland rice cropping in Benin Republic. However, there is some evidence that inland valleys in West Africa have particular constraints to crop production. Depending on the rainfall distribution, the heterogeneity of the topography leads to runoff causing erosion and loss of N. The objective of the study was to evaluate the efficiency of bunding and fertiliser application to increase rice productivity in relation to the position in the landscape.The experiment was conducted in a researcher managed on-farm trial located in Dogué village during 4 cropping seasons from 2007 to 2010. A split plot design was laid out with the combination of three factors: (1) slope position: middle slope (up) and down slope (down), (2) fertiliser inputs: control and combination of 40 kg ha^{-1} P and 60 kg ha^{-1} N, and (3) runoff control: with and without bunds. The total biomass (harvested 2 times during the growing cycle) and the grain yield across the seasons showed quite diverse response with respect to slope position and management practices. The slope position had a significant effect across the years for both final biomass and yield. The upslope presented higher yield during the first three years whereas in the year 2010 upslope plots produced the lowest yield. The fertiliser application started to have effect from the year 2009 onward. The impact of fertiliser has been high in the year 2009 leading to the increase of grain yield by 0.45 t ha^{-1} with fertiliser compared to the control. Bunding which was important in maintaining flooded conditions on the plots and preventing runoff, contributed to the conservation of nitrogen but also maintained high risk of iron toxicity. The iron toxicity could be considered as critical factor however its impact was variable depending on the annual rainfall pattern. We conclude that through consideration of different slope positions and rainfall patterns we are able evaluate the spatio-temporal variation of the effect of management options on rice productivity in inland valleys.

Keywords: Lowland rice, productivity, bunding, fertiliser, topography, West Africa

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Preliminary Evaluation of Improved Exotic Pigeonpea Cultivars in Limpopo (South Africa)

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Pigeonpea [*Cajanus cajan* (L.) Millsp.] is an important grain legume that originated from the Indian sub-continent. In Central and East Africa, it is grown mainly by smallholder farmers for its multiple benefits which include ability to improve soil fertility, human food and income generation. The crop is highly tolerant to drought making it appropriate for production in semi-arid regions. This study was designed to evaluate the agronomic performance of exotic pigeonpea germplasm particularly grain yield as well as the yield components in order to identify the cultivars suitable for production in the northern dry land belt of South Africa. A field experiment, consisting of 19 medium-duration exotic genotypes and one check cultivar, was conducted during the 2008/2009 cropping season at Thohoyandou (21°58' S; 30°26' E). The experiment was laid out as a 4×5 lattice design with three replications. There were significant ($p < 0.05$) differences among the genotypes in terms of the number of pods per plant, seed size and grain yield. The check cultivar produced the smallest grains (9.7 g per 100 grains). At least five cultivars produced >1.50 t ha^{-1}. Cultivar ICEAP 01508/10 obtained the highest (2.36 t ha^{-1}) yield. The study demonstrated the potential of the crop in the semi-arid region of Limpopo as represented by the agro-ecological conditions at the testing location. It would be interesting to embark on a genetic improvement programme aimed at increasing particularly the grain yield in order to maximise the benefits to farmers in the region as well as increase household food security.

Keywords: Agronomic performance, germplasm, grain yield, yield components

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Introduction and Adoption of Improved Cassava Varieties by Smallholder Farmers on the Island Idjwi in the Democratic Republic of Congo

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The island Idjwi in Lake Kivu is a densely populated area where 260 000 inhabitants live on 310 km^2 land area. Cassava is the main diet for the rural population and thus cassava based cropping systems predominate in an agriculture of smallholders ($<$0.5 ha) farming on remote and marginal lands with almost no access to agricultural inputs. Crop improvement and resource management are essential for increasing crop productivity and since cassava cultivation on the island is seriously menaced by Cassava mosaic disease (CMD), introduction of improved cultivars was the most immediate intervention to enhance cassava production at Idjwi. To reflect farmers' needs and awareness the rural communities were involved from start of the activities. Adaptation trials with 11 improved cultivars selected on the basis of their CMD resistance and other agronomic traits were set up at 3 sites on the island. Farmers associations were implicated in multiplication and varietal evaluations of the cassava cv. Mayombe, Nsansi, Mvuazi, Namale, Butamu, Disanka, Liyayi, TMS 96/0730, Sadisa, Sawasawa, TME419 and the local cultivar Nambiombio. The assessment of the harvest after the first year of cultivation showed that the cultivar Mayombe outperformed other cassava lines at all sites, essentially remaining free of virus symptoms, showing vigorous growth and high yield. Remarkable differences (root number & weight) were recorded for the cultivars indicating differences in soil fertility. Interestingly the local cultivar Nambiombio also performed well confirming that the health status of planting material strongly determines productivity of cassava cultivation. This model of community involvement in vulgarisation of improved varieties will continue and scaled up to reach more farmers. However already at this stage it can be concluded that the yield potential of the new cassava cultivars cannot be attained by subsistence farming thus successful adoption of improved cultivars require agronomic inputs, good farming practices and resource management.

Keywords: Improved cassava genotypes, introduction and adaptation to subsistence farming, virus resistance

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The Effects of Coatings and/or Rhizobia on the Growth of Alfalfa (*Medicago sativa* Verko.)

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Fertilisers containing nitrogen though widely used in agricultural systems are expensive for resource poor farmers coupled with the fact that they are a major source of greenhouse gases. Biological nitrogen fixation remains a major source of nitrogen input but under stress conditions only particular strains of rhizobia survive. Seeds coated with rhizobia together with other growth promoting substances can play a major role in agricultural systems since particular stress resistant strains can be introduced depending on the situation encountered.

The aim of this study was to (a) evaluate the effects of rhizobia coated grains compared to those without rhizobia on plant phenology and above and below ground biomass and (b) compare nodule parameters between coated and uncoated seeds. Treatments involved alfalfa seeds obtained from the company, Freudenberger coated with (1) humic acid + a plant fortifier + rhizobia (2) humic acid + a plant fortifier (3) uncoated seeds. Plants were sown in sand (pH 6.4) in pots (12 cm $\times$ 12 cm $\times$ 20 cm) in the greenhouse from February to April 2011. A 10 % kick off starter nitrogen was fed at the beginning of the experiment but subsequent fortnight fertilisation regiments excluded nitrogen. Plants were assessed every 2 weeks from the fourth week.

Results show that coats containing rhizobia produced plants which had significant (α = 5 %) higher number of leaves and tillers. Nodule count and both above and below ground biomass were also significant (α = 5 %) higher for plants resulting from coats having rhizobia compared to the other treatments. Plants resulting from coated seeds without rhizobia also showed significant improvement over those resulting from the uncoated seed. This implies that coating with rhizobia was advantageous and further investigations under field conditions are required.

Keywords: Biomass, nodules, phenology, rhizobia, seed coating

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Osmopriming Improved Germination Parameters of Water Deficit Stress derived Soybean Seeds under Low Temperature Condition

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In order to evaluate the effect of osmopriming on the germination characteristics of soybean (*Glycine max* L.) seeds formed on the mother plant affected by water deficit stress under low temperature conditions were investigated using a phytothron at Tarbiat Modares University in 2009. Treatments were arranged in a factorial experiment on the basis of randomised complete blocks with four replications. Factors consisted of: soybean cultivar (including DPX, Telar and 032), water deficit stress on mother plants including irrigation after 50, 100 and 150 millimeters evaporation from evaporation pan class A, representing control, mild stress and severe stress, respectively, and osmotic pre-treatment at 5 levels including non-priming and osmopriming with solutions of PEG6000 with osmotic potentials of -5, -10, -15 and -20 bar. After planting the seeds were put in a phytothron for 7 days at 10°C and for 4 days under condition of 16/8 h (day/night) with 30/20 °C. The results showed that osmoprimed seeds with PEG6000 have an increased final germination percentage, a normal seedlings percentage, coefficient of velocity of germination, mean daily germination, length and dry weight root and shoot compared with control (non-priming) in terms of low temperature. Osmotic pre-treatment has also reduced abnormal seedlings percentage and mean time to germination. So that the pre treated seeds with -20 bar solution had the highest germination percentage (92.8 %). Most normal seedling (87.6 %) were observed in pre treated Telar seeds with -10 and -20 bar solutions and the lowest abnormal seedling (8.23 %) were obtained in osmoprimed seed of 032 cultivar, with -20 bar solution. The longest root (14 cm) and shoot (9.94 cm) were observed in seeds pretreated with -10 bar solution and the shortest in non primed seeds. The pretreated Telar seeds with -10 bar solution had the highest dry weight root (14.6 mg) and shoot (20.91 mg) compared with control. According to our findings osmopriming strengthens soybean seed and will in this way allow an early culture even under low temeratures.

Keywords: Drought stress, *Glycine max*, low temperature, osmotic pre-treatment, soybean

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Yield Performance and Quality of Mediterranean and Mid-european Wheat Cultivars Grown under Different Ecological Field Conditions

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Cultivation of wheat in the Mediterranean climate frequently suffers from high temperatures and water deficits at the end of growing seasons. This holds true particularly for Turkey which has applied for EU-membership, but still faces problems of lacking quality standards for bread wheat. Future crop production in Mid-Europe, especially with spring wheats, will be confronted with increasing temperatures and at least more irregular rainfall in summer.

Hence, we studied yield structure and grain quality of 2 Mediterranean wheat cultivars (Golia and Gönen) and 2 Mid-European ones (Monsun and Taifun) under Turkish and German field conditions. The former ones were widely used in Turkey, but their quality was not classified, whereas the latter ones were classified as A- and E-standard. Two trials were conducted near Aydin/Turkey on a sandy loam from December to June in 2006/07 and 2007/08, and a third one in Berlin/Germany on a loamy sand (March to July 2010).

Inspite of extraordinary high temperatures in Berlin and unusually low rainfall during the reproductive period, average yield surpassed those at Aydin by 20 and 30 %. Cultivars displayed significant differences in yields in all trials, contrasting in varietal rankings at Aydin (Golia $\geq$-Gönen $\geq$ Monsun $\geq$ Taifun) and in Berlin (Golia$\sim$Monsun $\geq$ Gönen $\geq$ Taifun).

Both sites differed markedly with respect to yield components of ear density (ears/m^2), number of grains/ear and single grain weight (SGW) and showed contrasting varietal rankings of the ears/m^2 and SGW.

With respect to quality crude protein content (CP) of grains was highest in Taifun (E-wheat) followed by Golia, while Monsun (A-wheat) and Gönen displayed the lowest CP in Aydin. In Berlin, on the other hand, Gönen had the highest CP closely followed by Taifun and Golia, while lowest content was observed in Monsun. Nevertheless, wet gluten content and sedimentation values displayed a ranking as expected (Taifun $\geq$ Monsun $\geq$ Golia $\sim$ Gönen), irrespective of years and sites.

Mid-European compared to Mediterranean cultivars maintained the relevant quality traits under both climates, but not crude protein content under Turkish climate. On the other hand, the Mediterranean cultivars which performed excellently in Turkey, did not outyield Mid-European ones in Berlin.

Keywords: Adaptation to clinate change, stability of quality, varieties, wheat, yield

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Assessing the Effects of Storage of Shea Seeds on Germination and Seedling Growth in the Northern Region of Ghana

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The Shea nut tree is an indispensable multipurpose tree that provides several local and commercial products such as fruits, oil, pomade, candle and soap. It is also very important in the pharmaceutical industry for the manufacture of drugs. In spite of its numerous advantages in Ghana and elsewhere, the propagation of the tree is still in the wild and has not been fully domesticated. This study was therefore conducted to assess the potentials of establishing shea nut tree by seed. The objectives of the study were to assess the influence of storage of seeds after collection on the germination, the influence of the period of storage on germination and to determine whether percentage germination and seedling growth vary with geographical locations. Three villages were randomly selected in three districts for seeds collection. The villages were Nabogu, Yipala and Tuya. In each location, two stands of shea trees separated by at least 2–5 km were considered. Within each stand three trees (families) with fruits were sampled. The study revealed that the length of time of storage of shea seeds before sowing affected the percentage germination. Seeds sown without storage had the highest percentage germination which declined with increase in length of storage to 25 % after eight days of storage. However, germination percentage showed no significant difference among the locations. The study rather showed significant difference in shea seedling growth among the locations. Seedlings from Nabogu were significantly taller than seedlings from Yipala. However, seeds from Yipala were not significantly different from seeds from Tuya. The study recommends that, for high germination of shea seeds, seeds should be sown as soon as possible after collection. Also Nabogu seeds are preferred for its fast seedlings growth.

Keywords: Germination, seedling growth, shea tree

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Agronomic Characteristics and Performance of Local Common Bean Landraces (*Phaseolus vulgaris*) from Southern Brazil

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Common bean (*Phaseolus vulgaris*) is an important component of tropical and subtropical agroecosystems and plays an important role in human nutrition, especially in developing countries. The consumption of common beans, particularly when combined with rice, provide fibers, energy, vitamins, iron, proteins, and also essential amino-acids for a relative low cost, being a strategic and feasible alternative to alleviate malnutrition and increase food security. In southern Brazil several landraces of common bean are cultivated due better environmental adaptation or farmer's cultural preferences, but only few are commercially produced, posing a significant risk of loss of agrobiodiversity. In the western part of Santa Catarina State more than 120 landraces of common beans are cultivated and an intense effort in conservation of landraces is now in course. The aim of this work is to assist the efforts of farmers, research institutes and NGO's in the on farm conservation of these varieties by improving the knowledge of agronomic traits of landraces cultivated as second summer crop (off season). A field experiment was conducted in January 2011 at the experimental area of UNOESC in Sao Jose do Cedro County, West Santa Catarina State, Brazil. A field experiment with five local landraces (Enxofre, Verde, Pelé, Ângelo, Azulão) was done in a completely randomised blocks design with four replications and planting density of 266000 plants ha^{-1} to evaluate germination, plant height, pods/plant, number of grains per plant and pod, weight of 100 grains, and observed yield. The results were analysed for statistically significant differences. In summary, Verde had the lowest plant density (influencing almost all other factors), Enxofre and Pelé had the highest values; regarding height, Enxofre and Verde are shorter than the others; the numbers of seeds per pod was not different for all landraces; the weight of 100 seeds evidenced that Pelé produces smaller seeds, and Enxofre and Ângelo biggest seeds; although there were no significant differences for observed yield, Enxofre and Ângelo produced 741 and 634 kg ha^{-1}, respectively, indicating acceptable yields for off-season cultivation. Experiments with other landraces would be interesting to compare these results, so as other planting dates.

Keywords: Agrobiodiversity, beans, crop performance, food security, traditional varieties

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Water Saving and Organic Fertilisers Based Technology to Remediate the Health of Paddy Soils and to Increase Rice Productivity in Indonesia

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The rice production in Indonesia is dominated by permanent flooding or inundation system. Intensification of permanent flooding of paddy soils not only reduces the soil biological power significantly, but also restricts the roots growth. Virtually water to produce one kilogram of rice in continuously irrigated fields needs approximately 3,000 L of water, while the theoretical minimum at the crop scale is as low as 600 L. Under anaerobic condition, soil organisms cannot growth optimally and estimated only about 25 % rice roots can growth normally. Intensive use of inorganic fertilisers, particularly N fertilisers such as urea accelerates the mineralisation of soil organic matter. Consequently, soil organic content decreases rapidly. Various field studies indicated mostly of paddy soils in Indonesia has a low organic content ($<<$ 2 %). Under these conditions, the increasing of inorganic fertilisers dosage application may give a non significant effect on rice production and paddy soils can be categorised as a sick paddy soils. Remediation the paddy soil health can be achieved by managing the irrigation system and organic fertilisers application. The field results using several rice varieties in Indonesia revealed that the water saving technology combined with organic fertilisers (straw compost) can produce grain yield about 8–12 t ha^{-1} (average of an increasing about 50–150 % compared to anaerobic rice cultivation) and the water irrigation was reduced by at least 50 % and as well as inorganic fertilisers was reduced by 25 % This high rice yield is highly correlated with the increasing of roots zone about 4–10 times, number of productive tillers about 60–80 tillers, number of panicles, length of panicles and number of grain/panicle, and as well as due to the increase of soil biodiversity.

Keywords: Paddy soils, organic fertilisers, soil health, straw compost, water saving

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Animal production systems

From Marginal to Resilient Aquaculture Based Livelihoods in Coastal Mangrove Zones

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Increasing welfare pushes the global demand for luxury food such as shrimp. This growing demand has to be reconciled with concerns for the environment. In many countries mangrove forest is still threatened by short term benefits from timber and unsustainable practices of shrimp farming. Financial returns of semi-intensive shrimp culture systems in former mangrove forests are often short lived. Following declines in productivity as a result of deteriorating quality of bottom and water, and outbreaks of shrimp disease such as white spot virus, farmers *e.g.* in free access mangrove forests of East-Kalimantan reverted to extensive systems. Contrastingly farmers in the Philippines intensified and developed the so-called green-water (GW) technology. Using mangrove to filter the effluent water, such systems contribute to sustainable livelihoods in resilient aquatic ecosystems.

In East-Kalimantan, mangroves recover in areas where shrimp production collapsed, but in search for a livelihood people turn to other virgin natural resources. Can we prevent the cycle of destruction and collapse by reorganising the sector and create resilient livelihoods? Though the GW system spreads rapidly over the Philippines it's dissemination to *e.g.* Indonesia requires convincing financial data.

Using bio-economic modelling we explore potential constraints hindering uptake of apparently more sustainable strategies, to generate information for policy makers. After presenting financial data of GW and non-GW farms in the Philippines, we model development options of extensive farms in East-Kalimantan. We discuss the outcomes of the financial assessment, and the implications for options of sustainable mangrove-shrimp agro-ecosystems management.

Keywords: Better management practices, bioeconomic modelling, East Kalimantan, Indonesia, integrated mangrove-shrimp culture, multiple-demands

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Life Cycle Assessment (LCA) of Different Fish Production Systems

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Concerns about the sustainability of aquaculture prompt efforts to develop tools to evaluate its eminent environmental impacts. Classical environmental assessments provide only a very narrow view of the overall environmental impacts of culture fish production, which also requires energy, fish feed, transportation, package materials and chemicals. Life Cycle Assessment (LCA) has been used to assess the potential impacts of aquaculture production through material and energy flows throughout the product's life cycle. The analysis was made in order to examine the contribution of the different production phases to the total environmental impacts and to compare the different production systems of typical trout production. The product studied was cultivated ungutted rainbow trout, and the functional unit was one tonne of ungutted rainbow trout at farm gate.

Inventory analysis was carried out according to ISO 14040: 1997 and ISO 14044:2006 standard. Intensive trout production consumed substantial amount of electricity during the grow-out cycle, and results of the contribution analysis reveal that the consumption of electricity is an important hot-spot in the life cycle of this system. The environmental performance of both extensive and intensive trout production was strongly influenced with the provision of feed, accounting for over 90 % and 68 % of impact categories considered, respectively. In general, however, the importance of feed as a hot-spot decreased as the direct energy inputs in the culture system increased. Further study is needed to identify alternative to reduce impacts of hot spots in the life cycle of the product.

Keywords: Aquaculture, environmental analyis, life cycle assessment, sustainable development

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The Emerging Small-Scale Dairy Cattle Farming Sector in the Khorezm Province of Uzbekistan

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Since independence in 1991, reforms in the agricultural sector of Uzbekistan initiated small-scale private, instead of large-scale governmental farming. Yet, even during the Soviet Union era half of the cattle stock used to be reared by individual households. Presently the state regulates the number of cattle head per agricultural area and imposes some mandatory crops in private livestock and crop farms, respectively. A survey in the Khorezm province analysed livestock management and production in 56 private livestock (LF; on average 22 ha) and 80 household farms (HH; on average 0.2 ha). Dairy cattle in the irrigated mixed farms were fed a range of on-farm produced feeds. The main component was stover amounting to 69 % in HH and straw amounting to 67 % in LF. Green fodder with 14 % and silages (22 %) came next whilst broken grains and agro-industrial by-products added another 16 % in HH and 11 % in LF to cattle diets. The sporadic grazing along irrigation canals could not be quantified. While LF produced more metabolisable energy and crude protein than required by their ruminants, the feeds produced by HH covered less than half of the requirements. The HH farmers were however (in part) remunerated in-kind with feed as wage compensation for labour in private crop farms. The HH farms generated higher relative crop yields than their LF counterparts, while cattle productivity of both was similar, albeit low. Cattle mortality was not prominent because of a good access of the HHs to village veterinary centres and efficient contracting arrangements of LF with private veterinarians. Despite their very limited farm size, the HH farmers actively took part in the commercial farming sector, purchasing inputs for cattle and crop production and trading products. The long-term development potential of the HH farms needs further attention given their small size and since the income from livestock often is only an additional, but highly important source of income to them. At present HH farms are the key provider of livestock products.

Keywords: Dairy cattle, privatisation, productivity, smallholder, stover

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Perceived Feed and Water Constraints for Livestock Production in Lume and Siraro Districts, Ethiopia

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Livestock are kept in different agro-ecological zones and play a significant role for the household/national economy in Ethiopia. For possible interventions it is indispensable to understand the constraints perceived by livestock keepers. The present study aimed at assessing farmers' perceptions of feed and water constraints in Lume and Siraro districts, in the Ethiopian Rift Valley. A total of 320 randomly selected households (160 per district) were interviewed between July and August 2010, using a structured questionnaire. Key-informant interviews, focus group discussions with farmers and personal observations complemented the questionnaire survey. Ranked-orded logit model (ROLM) was used to analyse the rankings of the constraints by farmers.

Cattle, sheep, goats and donkeys were the most common livestock species kept in both districts. Tef and maize were the main cereal crops produced in Lume and Siraro, respectively. The results of ROLM showed that shortage of feed, shortage of water and livestock diseases were the top ranked constraints for livestock production in Lume, whereas the respective ranking in Siraro was shortage of water, shortage of feed and livestock diseases. Different water sources, namely rivers, lakes, hand-dug wells, stand pipes, springs and ponds were used by people and livestock in Lume, whereas the Bilate River was the only permanent surface water in Siraro, making the extreme south-western border of the district. Therefore, motorized boreholes and ponds were the common water sources for people and animals during all seasons. In most cases, uncontrolled use of water sources by livestock was practised in both districts. Straw and stover were the most important feed resources in both districts. According to farmers, grazing land is nowadays restricted to waste land, roadsides, edges of cropping fields and river banks, as well as fallow land during the wet season and crop residues during the dry season associated with land competition for cropping. Intervention measures towards an increase in alternative feed resources, better water management and an improvement of existing indigenous methods of rain water harvesting are recommended.

Keywords: Ethiopia, feed shortage, mixed farming systems, water sources

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Improved Feeding Strategy Increases the Efficiency of Indigenous Pig Production in Southwest China

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In Xishuangbanna, a tropical mountainous region in Southwest China, agriculture is dominated by small-scale mixed farming in often isolated areas with poor infrastructure. Most important livestock species with regard to food production are pigs of predominantly local breeds. Diets mainly consist of banana pseudostem (BTR) harvested in the rainforest, corn, rice hulls, meal leftovers and grasses, depending on season. Growth performance of fattening pigs is very poor, making pig production inefficient. Optimising the feeding regimes would be one measure to increase the economic success of pig rearing. The objective of the present study was to investigate the effects of an improved diet on the growth performance of the local pig breed.
A feeding trial was carried out with 20 piglets bought from local farmers; the average weight was 16.4 kg ($\pm$ 5.4). Sibling piglets were separated into two experimental groups. Group 1 received the traditional diet consisting of 70 % BTR and 30 % corn (fresh matter basis), while group 2 received an improved diet consisting of 46 % BTR and corn each plus 8 % soybean meal. The two groups were kept and fed in the same stable in different compartments for 88 days. Water was available *ad libitum*. The mean daily fresh matter intake of pigs in group 1 and 2 was 3.39 and 2.08 kg d^{-1}, while the dry matter intake (DMI) was 1.11 and 1.01 kg d^{-1}, respectively. Crude protein and NDF intake were 95 and 178 g d^{-1} in group 1 and 146 and 137 g d^{-1} in group 2. The intake of digestible energy was 21.0 and 23.3 MJ d^{-1} in group 1 and 2. Intake of all components was different between the groups ($p < 0.05$). The average weight gain was lower in group 1 (6.7 kg) than in group 2 (10.5 kg; $p = 0.065$), resulting in an average daily gain of 0.08 and 0.12 kg. The feed conversion rate (g DMI g^{-1} weight gain) was 14 and 8 in group 1 and 2.
These results show that already small improvements in diet composition can increase the efficiency of pig production in this region tremendously.

Keywords: Banana pseudostem, feeding strategy, local pig breed, Xishuangbanna

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Importance of Guinea Pig Husbandry for the Livelihood of Rural People in Tanzania: A Case Study in Iringa Region

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Little is known about guinea pig husbandry in eastern Africa, where smallholder farmers have discovered the small rodent as a useful source of meat, manure and cash income for several generations. This study aims to investigate the importance of guinea pig husbandry for the livelihood of rural people in southwestern Tanzania, where the Iringa Region has been on the margin of development due to limited market access and inadequate road infrastructure. The investigation targets potential improvements of guinea pig husbandry in order to be able to enhance productivity and thus upgrade people's nutritional and economic status. In individual interviews, carried out during February and March 2011, 165 households from Njombe and Makete Districts in Iringa Region provided survey data on their socio-economic status, nutritional habits, preferences in livestock keeping and meat consumption as well as guinea pig husbandry methods.

In order to evaluate the importance of guinea pig meat, respondents were asked to rank meat-types consumed in their households according to quantity. Guinea pig meat was ranked second after beef, together with pork and chicken. Goat meat was ranked last. Guinea pig keepers ranked guinea pigmeat first, together with beef. Second rank was shared by pork and chicken. Consumption of goat meat was lowest. During the time of the survey more than half of the households kept guinea pigs, while another third used to keep them previously. Mean stock size in guinea pig keeping households was ten. Compared to chicken, guinea pig was particularly valued for its flexibility in terms of forage acceptance, disease resistance, manure quality, and low maintenance and acquisition costs. Productivity was constrained by bad hygienic conditions, low feeding quality and quantity as well as uncoordinated mating, resulting in inbreeding and indirect selection for small size. Under the conditions of southwestern Tanzania, Guinea pigs increase meat variety with little demand for resources or effort, but farmers lack awareness of obstacles and potentials. They consequently require training and information, which is – up to now – not provided by any of the agricultural or livestock extension services in both study areas.

Keywords: *Cavia porcellus*, Guinea pig, nutrition security, unconventional livestock

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Identification of a Suitable Farm Type for the Development of Smallholder Beef Production in a Mountainous Province of Northern Vietnam

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In Vietnam, beef is in a high national demand. The aim of this study is to identify the farm type and socio-economic conditions of the household farm suitable for the development of smallholder beef production in mountainous regions of northern Vietnam.

This study was conducted on a stratified sample of 2 farm types: smallholder mixed farms with individual integrated crop and livestock production (small farms) and smallholder mixed farms with a tendency to increased herd size based on natural pastures and cooperative organisation (medium farms) in the uplands of Son La province. Further, data from a representative random sample of 299 smallholder mixed farms were collected in a second survey. In this survey, the relative poverty status of the household was assessed using terciles, based on per-capita daily expenditure as a measure of monetary poverty or wealth.

Results of the first survey show that lowland small farms had higher costs for cattle than medium and small farms in the highland, those having access to communal pastures. Lowland small farms had high outputs from the non-market value of cattle, while small and medium highland farms had high output from stock value. This was due to the fact that the small farms in the lowland kept fewer cattle than the small and medium farms in the highland (average of 2 cattle per farm compared with 4 cattle per farm and 9 cattle per farm, respectively) because of forage and labour shortage. In the highland, medium farms working as groups of farms kept more cattle than the individual small farms. The results of the second survey show that better-off farmers reduced competition between cattle with other livestock species by more frequent adoption of innovations, while poor farmers reduce the numbers of animals. For the poorest farmers small animals were more suitable than cattle. In conclusion, smallholder cattle keeping in the study region has not yet been practised as a beef production activity to generate regular income. Highland farms organising cattle keeping cooperatively based on natural pastures and thus saving labour were identified as the most promising farm type for future development of profitable beef production.

Keywords: Cattle production, interdependency, livestock production, mountainous regions, poverty levels, Vietnam

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Prevalence of Helminth Infestation in Pastoral Sheep and Goat Flocks in the Cholistan Desert of Pakistan

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Intestinal helminths constitute a major problem for livestock keepers in Pakistan, since chronic infestations lead to distinct losses in livestock productivity, particularly retarding growth of young animals. This project evaluated the prevalence of intestinal helminths in pastoral sheep and goat flocks of the Cholistan desert, a lesser developed and relatively poor area, where livestock husbandry forms the backbone of the regional economy.

Faecal samples – 300 of sheep and 300 of goats – were collected from 60 pastoral flocks comprising 8–150 animals in three different localities of Cholistan during February–April 2011, whereby the ratio of suckling, young, and adult animals was 20 : 40 : 40 and the male to female ratio was 30 : 70. Five to ten grams of faeces per animal were collected in a zipper polythene bag and refrigerated until analysis. By using direct and indirect (floatation) techniques, faeces were examined and helminth eggs and larvae were identified.

Overall prevalence of intestinal parasites amounted to 76.8 % in the studied 600 small ruminants. Of the goats, 77.0 % were infested with helminths, whereby the highest prevalence was recorded for nematodes (39.7 %), followed by trematodes (6.7 %), and cestodes (2.3 %). In sheep overall prevalence of intestinal parasites was 76.7 %. Nematodes were again most frequent (46.0 %), followed by trematodes (6.0 %), and cestodes (3.3 %). In addition to helminthiasis, protozoa infection was also determined in 2.0 % of goats and 0.7 % of sheep. Mixed infestations accounted for 26.3 % and 20.7 % of all cases in goats and sheep, respectively. While in goats slightly more males (77.4 %) than females (76.7 %) were infested, the opposite was found in sheep (69.3 % males, 79.5 % females). With respect to age groups, helminths were especially prevalent in suckling goats (87.4 %) and sheep (85.4 %), although infestation levels in young animals (79.0 % in both species) and adults (goats 70.5 %, sheep 72.1 %) were also considerable.

The results indicate that particular attention should be paid to regular de-worming of the animals, and helminth species should be screened for resistance against anthelmintics commonly used in the area.

Keywords: Cestodes, intestinal parasites, nematodes, protozoa, small ruminants

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Cashmere of Nomadic Raeini Goat: Assessment of Quality, Comparative Advantage, Development Options for Industry

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This experiment aimed to identifying characteristics and comparative advantage of cashmere of Raeini goat kept by nomads in Kerman province of Iran for development of industry. In April 2010 a total of 709 male and female cashmere goats of 1, 2 and 3 years of age belonging to 30 nomadic herds within 20 kilometers of Baft city were studied. Samples of fibre were taken from the left midside of goats and analysed using standard objective measurements for mean fibre diameter (MFD), coefficient of variation of fibre diameter (FDCV), staple length (SL), fibre curvature (FC), cashmere fibre, and (CF) percentage. Fleece was shorn and weighed to measure fleece weight (FW). A general linear model was used to analyse the data and measure the relationships between cashmere and fleece attributes. The mean (s.d) for FW, MFD, FDCV, SL, FC and CF were 506.90±7.08 gm, 19.65±0.05 μm, 22.7±0.11 %, 54.26±0.26 mm, 63.08±0.32 °/mm and 56.49±0.45 % respectively. 22 % of all cashmere samples were finer than 18.5 μm suitable for worsted and semi-worsted knitwear. Of these cashmere samples, 27 % was finer than 17.5 μm totaling to 6 % of all samples. A further 78 % of the cashmere was coarser than 18.5 μm. All samples were longer than 40 mm with 38 % between 40 and 50 mm, 46 % between 51 and 60 mm and 16 % between 61 and 80 mm. All samples had a curvature greater than 40°/mm with 17 % between 40 and 55°/mm, 61 % between 56 and 70°/mm and 22 % between 71 and 94°/mm. There is substantial scope to improve the commercial value of fibre produced by Raeini goats kept by nomads which produce high value classification cashmere equivalent to international standard quality.

Keywords: Cashmere, curvature, fibre diameter, fleece weight, goat, staple length

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The Effect of Feed Supplementation on the Productive and Reproductive Performance of Desert Ewes in Rangeland of Kordofan, Sudan

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Feeding experiments were carried out with Sudanese desert sheep in Northern Kordofan during the dry season. The aim of the present work was to investigate the effects of supplementary feeding during mating on ewe productive and reproductive performance.

A total of 340 mature ewes maintained under natural rangelands were chosen during the breeding season. The ewes were divided into four groups of similar body weight and age. They were randomly assigned to four supplementary treatments. Group one was used as a control, the second group was supplemented with diet A, the third group was supplemented with diet B and the fourth group with diet C. All ewes in the three supplemented groups were flushed (receiving supplement for 45 days at mating time) and steamed-up (receiving the supplement for 45 days pre-lambing) while the control group received no supplements as in the farmer practice. Eighteen mature rams were introduced to the four groups at the ratio of 1 ram: 20 ewes.

Body condition score of ewes (BCS) were estimated in breeding, mid pregnancy and lambing period. Number of services, number of ewes mated; pregnant, non pregnant, aborted and lambed were recorded. Number of lambs born and weaned was also recorded. The lambs were weighed at birth and each two weeks. The results obtained indicated that, supplementation improved the BCS compared with farmer practice. Ewes supplemented with diet B and C were the higher ($p < 0.05$) body weight and followed by diet A. Supplementation improved ($p < 0.05$) fertility, prolificacy, fecundity, pregnancy, weaned lambs, and abortion rate compared with non supplemented ewes. The reproductive performance was improved as ewe's age increased. This study indicated that, supplementation during mating is an efficient strategy to reduce nutritional stress in desert ewes and increase their productivity.

Keywords: Desert ewes, Kordofan, productive, reproductive, Sudan, sheep supplementation

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Milking Management and Use of Oxytocin in Urban and peri-Urban Dairy Herds of Faisalabad, Pakistan

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Urban and peri-urban dairy production has been growing constantly during the past decades and continues to gain importance; about 5 % of Pakistan's milk comes from urban and 15 % from peri-urban producers. A study was conducted to evaluate the efficiency of this production system in Faisalabad, third-largest city of Pakistan. Using a structured questionnaire, interviews with 145 urban and peri-urban (4.0–9.4 km from city centre) milk-producing households (HH) were carried out during 08–10/2009. Based on cluster analysis, four types of dairy farmers were identified, namely semi-commercial smallholder mixed dairy-crop farmers (n=43), semi-commercial smallholder dairy farmers (n=30), commercial smallholder dairy farmers (n=53) and commercial large-scale dairy farmers (n=14). Of each type five HH were randomly selected for qualitative and quantitative on-farm monitoring of management of dairy animals during 06/2010–06/2011.

Dairy animals were milked twice daily, exclusively by hand. During the period of high milk flow (12/2010–03/2011), intra-muscular injection of 2 ml oxytocin before milking was practised by 90 % of the farmers to stimulate milk letdown in 52 % of the monitored lactating buffaloes and 15 % of the lactating cattle. Oxytocin can be easily purchased for as little as 18–20 rupees/50 ml from local shops, even at village level. In general the calves of the injected animals had died, had been separated for sale or were not accepted by the dams. Some lactating animals were injected once daily while most of them received oxytocin at both milkings.

While oxytocin generally increases milk yield by enhancing milk ejection, the reported magnitude of increase is quite variable, ranging from zero to a maximum 12 % of milk production. Animals regularly treated with oxytocin become drug habitual, as repeated injections interfere with normal milk secretion and inhibit the normal ejection reflex. Prolonged use of oxytocin also causes fertility disorders such as poor estrus signs, low conception rate, high embryonic mortality, shortened lactation period, increased abortion rate, calf death and incidences of mastitis, as well as delayed puberty. These problems are currently addressed in progeny-history interviews targeting each milking animal in the 20 monitored herds.

Keywords: Buffalo, cattle, fertility, milk let down

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Comparison between Mubende and Boer × Mubende Crosses for Biometric Measurements and Weight-for-Age in Uganda

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Goat farming is considered pivotal in strategies directed toward improved rural livelihoods in Uganda. However, goat farming in Uganda faces two challenges, (1) low productivity of indigenous genotypes and (2) missing performance and pedigree data of indigenous and crossbred goats. The aim of this study was to compare the performance of Mubende and Boer × Mubende crosses for biometric measurements (heart girth (HG) and Body length (BL), scrotal circumference (SC)) and weight-for-age. A total of 819 goats that comprised Mubende (n = 296), the first (F1; n = 299), second (F2; n = 145) and third filial (F3; n = 79) generations were randomly selected from over 2000 randomly breeding goats at Ruhengyere and Sanga Field Stations, Kirihura district, Uganda. The goats were aged using their teeth and assigned to five age groups (0–1, 1–2, 2–3, 3–4 and >4 year(s) old). Based on population means, the F3 weighed heavier than F2, F1 and Mubende by 7.91 kg, 11.3 kg and 15.5 kg. Based on age group means only F3 aged 1–2, 2–3 and 3–4 year(s) weighed heavier than the F2 by 8.6, 8.3 and 0.6 kg while 0–1 and >4 year(s) old weighed lighter by -2.6, -3.2 kg. The F3 weighed heavier than the F1 in all age groups. The F2 aged 0–1, 3–4 and >4 year(s) weighed heavier than the F1 by 4.5, 4.7 and 3.5 kg with 1–2 and 2–3 weighed lighter by 3.9 and 5.1 kg. All the crosses weighed heavier than the Mubende across all age groups the greatest differences in LWT occurring between the Mubende and either the F3 or F2. The F2 had the lowest average BL (41.2 cm) and SC (15.5 cm). Two equations were derived to estimate body weight based on HG (R^2 = 0.78) alone and both HG and BL (R^2 = 0.78). The LWT correlations with HG, BL and SC were 0.86, 0.73 and 0.79. These results provide more information on the growth related traits of the Mubende and its Boer crosses and give justification for genetic improvement of the Mubende for meat production using the Boer goat.

Keywords: Goats, Uganda

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Dairy Goats in Rural Development: Determinants of Viability and Sustainability of a Breeding Programme

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Dairy goat development projects and programmes are increasingly justified and funded solely on their potential to aid the poor. However, the acceptance of dairy goats is highly dependent on the assumed benefits and risks attached as well as personal perception and attitude of the individual farmer. This study established viability and factors that drove the viability of dairy goats as an enterprise. Data was collected by a survey on 71 farmers selected by random sampling in three provinces of Kenya (*i.e.*, Coast, Nyanza and Rift Valley) using a set of pre-tested structured and semi-structured questionnaires. Using gross and net margins from dairy goat farming as an indicator of economic viability, dairy goat beneficiaries of the Heifer Project International-Kenya were separated into viable or non-viable enterprises. A logit model based on the dependent variable of a farm being viable or non-viable was used to determine main factors that determined a dairy goat's enterprise economic viability. Results indicated that 54.9 % of the farms were viable at the gross margin level and 47.9 % at the net margin level. Differences in gross and net margins across agro-ecological zones were attributed to milk prices. The model results indicated that older farmers, a higher education level and longer distance to the market had a negative effect on economic viability while a large family size, longer distance to veterinary centre and hired labour had a positive effect. Female recipients tended to perform better than the men. To enhance success of the dairy goat breeding programme, labour, markets, linking activity to gender, age and good husbandry practices require serious attention. Besides, farmers' awareness of the market demands within and outside the community is important in establishing production goals, and may be crucial to achieving a positive gross margin. Despite the existence of non-viable enterprises, the few present suggest the possibility of obtaining reliable incomes from the enterprise. Redoubling of effort or re-orientation of production to match the local and external requirements would, however, be necessary.

Keywords: Breeding programme, dairy goats, development, viability

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Incorporation of *Mucuna pruriens* as a Protein Supplement in the Diets of Lactating Dairy Cows

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Napier grass is predominantly used as a feed resource for cattle in Rwanda. Velvet bean (*Mucuna pruriens*) is one of the herbaceous legumes that can be incorporated into the smallholder farming sector to improve milk production during the dry season. The objective of the study was to evaluate the effect of supplementing napier grass (*Pennisetum purpureum*) with velvet bean on milk yield and milk quality of lactating dairy cows. Eight in-calf crossbreds (Jersey × Ankole and Sahiwal × Ankole), average age of 3 years and liveweight of 230–280 kg were used in the study. The animals, individually housed, were divided into two groups and allocated to two treatment diets: Napier grass alone and Napier grass with *Mucuna*. During the study all animals were offered napier grass as the basal diet plus 3 kg of crushed maize, distributed in 2 rations per day. The velvet bean forage was harvested at 10 cm from the ground level and chopped into pieces of about 15–20 cm length. One group of the cows was supplemented with 8 kg fresh (equivalent to 2 kg DM) velvet bean forage daily, split into two equal rations after milking. The adaptation period was 14 days, the measuring period 77 days. The cows fed on velvet bean had higher milk yield ($p < 0.05$) compared to the cows fed napier grass alone with an average milk yield of 8.56 and 6.71 kg d^{-1}, respectively. The supplementation of lactating cows with *Mucuna* increased milk production by about 28 %. However, the milk composition of the two treatments was not significantly different ($p > 0.05$). The protein content of the milk was 3.57 % from the cows fed napier grass based diet and 3.53 % from the cows fed napier with velvet bean. The fat content was 3.8 % from napier grass based diet and 3.95 % from napier supplemented with velvet bean. The cows that were fed napier grass with velvet bean had higher milk production throughout the experimental period. The study showed that forage legumes such as *Mucuna pruriens* can be effective protein supplements for use in feeding the lactating dairy cows in Rwanda.

Keywords: Legume forage, milk quality, Napier grass, protein supplements

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Performance of Smallholder Dairy Farming in Nakuru County, Kenya

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The Kenya dairy sub-sector has been undergoing developments since the 1980s in the areas of adoption of intensive dairy farming especially zero grazing. There have been concerted efforts by the government and other development partners to commercialise the sub-sector so as to make it more profitable to farmers, especially smallholder farmers, but the profitability in the sector continues to be variable with some smallholder farmers making losses. The causes of the varying profits have not been empirically established with the influence of institutional arrangements and financial factors contributing to this inconsistency not fully established. The study dwelt on establishing the critical institutional arrangements and financial factors that constrain the profitability of small-holder dairy farmers in Nakuru County. A multi-stage sampling procedure was used to select respondents. Data was collected by structured interviews at the farm level. Data Envelopment Analysis (DEA) was used to come up with profit efficiency rankings among the farmers, and the Frontier Model was used to establish the factors that constrain profit efficiency. The mean efficiency according to the results was 86 %. The farm and farmer characteristics that were significant in explaining profitability efficiency according to the frontier results were: feeding system, breed type, and gender. The financial characteristics included debt amount and debt asset ratio. Additionally, issues of trust were also found to have an effect on profitability, and they included trust on local buyer price, trust on institutional buyer unit of measure, and trust on middlemen unit of measurement.

Keywords: Dairy, Kenya, livestock, smallholder farmers

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Milk Production by Small-Scale Farmers in the South of Rio Grande do Sul, Brasil

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In Brazil, a total of 807,587 farms are considered small-scale (family farm) establishments, where land property is less than 100 ha, work is supervised by the producer, and family labour prevails over hired labour. Milk production is a socio-economically relevant activity for many family farms and plays an important role for the regional development.

The performance of small-scale dairy farms differing in cattle management and milk marketing strategies was studied in the cities Cangucu (31°23'S 52°40'W), Pelotas (31°46'S 52°21'W), and Sao Lourenco do Sul (31°22'S 51°59'W) in Rio Grande do Sul state. A baseline questionnaire was administered to 200 farm households in summer 2010. Using categorical principal component analysis (CATPCA) and two-step cluster analysis (SPSS 19.0), baseline data on farm assets and activities were used to classify small-scale farmers into three groups: Group I milk producers; Group II cash crop and milk producers; Group III cash crop producers with surplus milk marketing.

The size of the cattle herd (heads) was largest in Group I, averaging 114 (SD 71.9, n=7), followed by Group II (31 SD 13.4, n=74), and Group III (12 SD 7.5, n=118). Milk production of cows in lactation at the time of interview (l/day) averaged 11 SD 10.3 in Group I, 7 SD 4.1 in Group II and 5 SD 4.3 in Group III. Group I farmers had more pasture land (ha) available for their animals, namely 51 SD 49.4, than Groups II and III (9 SD 8.9; 5 SD 8.1). The contribution of livestock husbandry to family income (%) averaged 71 SD 33.8 in Group I, 59 SD 25.1 in Group II and 16 SD 14.1 in Group III. A significant correlation was observed in Groups I, II and III between cattle herd size and pasture area (r=0.88; r=0.51; r=0.58). In Group III the income contribution of livestock was correlated with cattle herd size, pasture area and milk production (r=0.41; r=0.42; r=0.35). Overall, wide differences existed for the various variables between Groups I and III. Whether these affect the resource use efficiency and profitability of a farm's dairy unit will be determined by further bio-economic analyses.

Keywords: Cluster analysis, farm structure, farmer classification

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Conservation, Promotion and Utilisation of Indigenous Lulu Cattle (*Bos taurus*) for the Sustainable Development on the Marginalised Area of High Altitude of Nepal

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Livestock is an integral part of nearly all rural livelihoods in Nepal. A very high proportion of poor and marginalised farmers depends on livestock as their main or supplementary source of income. Cattle and buffalo contribute more than 70 % to the livestock sector. In addition, because of the religion, cattle are perceived as the holy animal by the Hindus whose percentage is more than 75 in Nepal.

Only about 12 % of the total cattle of Nepal are improved. The rest of the cattle are non-descript type indigenous breeds. These indigenous cattle can withstand even in a very harsh climatic condition. Lulu is one of the very efficient indigenous breeds suitable to raise at an altitude of 7,500 to 14,000 feet asl. It is very important to eradicate the extreme poverty and hunger (MDG 1), to improve the nutritional status (MDG 2), environmental sustainability (MDG 7) and to develop global partnership (MDG 8) in these marginalised areas of Nepal. However, a detailed study of this breed, especially on milk production potentiality, nutritional requirement, present status to sustain the breed is not done yet in Nepal.

A survey conducted in November 2010 to February 2011 revealed that Lulu breed is the symbol of high altitude cattle farming especially of Mustang and Manang districts of Nepal. However, because of unmanaged forage pasture and range land, out migration (especially youth migration from rural to urban areas) and global warming, their number is declining day by day. The study concluded that the number, production and productivity of the breed can be improved if the direct custodians (principally farmers) get appropriate incentives as stated in Article 11 for the Conservation and Sustainable use of the Agrobiodiversity in Nepal. Furthermore, the value chain and organic product production approaches would also be very useful for the conservation, promotion and utilisation of these vulnerable species of the cattle.

Keywords: Conservation, high altitude, incentives, indigenous cattle, marginal people, Nepal

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Goat Production System and Opportunities for Market Orientation in Southern Ethiopia

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This study was undertaken to describe goat production and marketing systems, determine production potentials and opportunities for market-orientation in southern Ethiopia. The study area was stratified in to Moist Kola (lowland), Moist Weyina Dega (midland) and Dega (highland) agro-ecologies. Flock monitoring was carried out from September 2006 to March 2007. Three primary, one secondary and one terminal markets were studied at Dale, Tula and Hawasa, respectively using Rapid Marketing Appraisal (RMA) technique. The average family size was 7.5 ± 0.25 per household and about 75 % of the male and 50 % of the female headed households were literate. The overall mean goat holding per household was 5.98 and varied among agro-ecologies. Mean weaning age (WA), age at first mating (AFM), age at first kidding (AFK), kidding interval (KI), and litter size were 5.2, 9.7, 14.9, 8.6 months and 1.62, respectively. WA in Moist Dega (6.47 ± 0.45) was longer ($p < 0.05$) than in Moist Weyina Dega and Moist Kola. KI was 8.56, 7.27 and 8.57 months in Moist Dega, Moist Weyina Dega and Moist Kola, respectively. Mean litter size for Moist Kola (2.07) was higher ($p < 0.05$) than in Moist Dega and Moist Weyina Dega. Goats in Moist Kola had longer ($p < 0.05$) lifetime kidding of 16.27 years than those in the other two sites. TThe major feed sources were shrubs and trees in Moist Kola, while crop by products, crop residues, enset (false banana) and fruit trees, vegetables and chat leftovers were the main feed sources for tethered and herded goats of Moist Weyina Dega and Dega. Shortage of feed, diseases and marketing are the major constraints affecting goat production. The increasing local and export demand for goat meat, the experiences of flock holders to carry out small scale goat fattening activities, fast growing goat meat butcheries and demand for goat market, the conduciveness of the agro-ecologies and sufficient family labour are some of the opportunities to develop a market-oriented goat production in the area.

Keywords: Ethiopia, goat, market orientation, production

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Dairy Cooperatives Development in Eastern Afghanistan – Minimal Technological Equipment for Sustainable Functionality of Milk Collection Centers

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The Logar province in Eastern Afghanistan is location of deployment of Czech Provincial Reconstruction Team of Czech Republic (CZE PRT) – double headed Civilian/military unit, dedicated to assist Afghans in reconstruction of their region. Agriculture experts of PRT systematically map ways of efficient assistance delivery to vulnerable farmers. Identification and ability to reach repeated contact with target groups in unstable environment is the key issue for all PRT driven reconstruction activities. Since 2009, authors have been cooperating on construction of 6 milk collection and processing centres (MCCs), which were supposed to help increase the self-sufficiency of the province in dairy production, moreover to encourage them in building of free market.

The main topic of this paper is the description of technological equipment selected for typical centre constructed and its real impact on cooperative economy after first year of MCC use. The data collected are compared with data from unequipped centres to measure real financial impact of such development project.

Obtained data were combined with information about cost of such minimal low-tech equipment (allowing cooperative's full incorporation in local dairy value chain), defined time horizon for economical viability of such investment (in case of other cooperative self-investments into MCC), as well as possibilities for future development and widening of the value chain, *i.e.* product portfolio which means also opening to new markets.

The result confirmed expectations about dramatic income increase for equipped cooperatives, but the income generation of cooperatives without equipment stays far below the modernisation investment needs. The solution can be seen in long term loans or government-assisted linkages to important markets.

Keywords: Afghanistan, agriculture, dairy, economy, equipment, reconstruction, sustainability, technology

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Guinea Fowl Rearing: A Tool for Poverty Alleviation in Zimbabwe

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Food security is a major global concern that requires proper balance between saving the environment and feeding the poor and as a consequence, modern agricultural needs to change radically to cope with growing population and climate change without irreversibly damaging the environment. It is globally recognised today that guinea fowl is an ideal vehicle that can be utilised to curtail poverty in the developing world. In order to verify this assumption, the potential of the role of investing in guinea fowl rearing was investigated through research utilising guinea fowl production practices and corresponding productivity potential. The study investigated guinea fowl production practices and corresponding productivity potential of 73 fowl flocks using RRA techniques. Eight-one percent of flocks were found to free range with the remainder, semi-intensive. The helmeted guinea fowl was the only breed found represented by several varieties, an observation for future improvement in selection of the most fertile variety for promotion. Important but surprising was the finding that 69 % of flocks were managed by males: mean flock size found was small: 8 ± 6 with variation of 1 to 30 $^{\text{birds}}/_{\text{flocks}}$ compounded by significant variation in responses among productivity traits, as highlighted by findings that mean annual egg production estimate was 89 ± 50 ranging from 10 to 200 per hen while young produced averaged 64 ranging from 0 to 100; weaned young for market, approximating 60 ranging from 1 to 100. Taking fowl rearing output numerical perspective, it was clear that diminished numbers of young keets being produced impacted negatively on the economic viability within the fowl keeping community, therefore, there needs urgent address to minimise losses thereby improving the numbers of young fowl presented for market. In view of the massive egg production reported in this study, it is recommended that keepers be encouraged to alternatively consume and or sell some of the eggs thereby curtailing economic losses incurred as reported, finally, it is clear that massive potential exists in guinea fowl rearing using free range.

Keywords: Extensive, guinea fowl, productivity, rearing, scavenging, semi-intensive

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Integrated Rice-Fish Culture for Poverty Reduction in Riverine Smallholder Agriculture of the Eastern Amazonian Periphery

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Irrigated rice ranks among the most intense grain-, and fish culture among the most intense animal-production systems. Integration of both not only combines productivity in an additive manner via niche partitioning, it also offsets a series of positive interactions such as pest, disease and weed control by fish, and improved nutrition of both fish and rice, thus reducing the needs for external inputs. Integrated rice-fish culture (IRF) could therefore offer a unique opportunity for poverty reduction where land is limited, in environmentally sensitive riverine areas where the use of pesticides is undesirable. Here, we report on the economic balance of 4 on-farm IRF units in smallholder agriculture on the banks of the Mearim river, coastal lowlands of eastern Amazonia. We tested different combinations of fish with different feeding habits, rice was established via transplanting (25×25 cm). Production occurs during the dry season with complete water control, rice grows for 120 days and fish for 5–6 months (depending on the onset of the rainy season and on fish prices). Rice yields were 6–7 Mg ha^{-1} (as opposed to about 400 kg ha^{-1} in rainfed upland rice) and fish yields 1.600–1.900 kg ha^{-1}. Installation (initial investment for dyke building, pumps and tubing system) cost R$ 8.100 (or € 3.432) per ha in IRF, as opposed to R$ 3.150 (or € 1.335) per ha in irrigated rice, external inputs cost R$ 4.315 in IRF as opposed to R$ 3.489 in irrigated rice. Depending on fish combinations, net financial returns were R$ 8.620 per ha and year in IRF (vs. R$ 2.657 in irrigated rice), resulting in a monthly income of R$ 718, 168 % above the minimum wage and 225 % above sole irrigated rice production. Thus, IRF is a viable option for smallholder agriculture. Future research is directed at reductions in external nitrogen inputs via *Azolla*, at improved initial fish nutrition, at horticulture and fruit production on the well-drained dykes, and at the effects of IRF on water quality and CH_4 and N_2O emissions. In parallel, efforts are made for massification of this promising technology in the region.

Keywords: Food security, integrated farming, river people, rizipisciculture

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Comparison of Shrimp Farming Systems: Evidence from Bangladesh

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Worldwide, aquaculture is continuing to be fastest-growing sectors among animal food production considering growth. Black tiger shrimp (*Penaeus monodon*) is one of the most popular species for aquaculture as it has high demand in the international market. Shrimp aquaculture is thriving sector in Bangladesh as it provides quick profit and it contributes to poverty reduction and economic development. Shrimp aquaculture has a long history in Bangladesh due to suitable agro-climatic conditions, adequate water resources and cheap labour force. The impacts of environmental and socio-economic have increasingly become a matter of concern for both government and public. The doubts about the sustainability of shrimp aquaculture are surfacing. As a reaction of negative impacts, organic aquaculture is now recognised as an alternative farming systems that can solve environmental problems and can provide safe aquatic food to the consumers. Hence, organic shrimp aquaculture has emerged as an alternative farming enterprise for farmers especially in the south-western districts of Bangladesh with the involvement of Germany based importing organisation WAB-trading international. The aim of the study is to understand the potential of organic shrimp aquaculture development in Bangladesh and to identify the farmer's characteristics and income contribution. Data was collected in 2009 from three farming systems such as organic (n= 144), conventional (n= 60) and rice-cum-shrimp (n= 60) in the Kaligonj and Shyamnagar sub-districts through questionnaire interviews, transect walks and focus group discussions. The mean productivity of organic shrimp is comparatively higher as opposed to conventional and rice cum shrimp aquaculture. In comparison to the three farming systems, monthly income, ownership of land under shrimp farming and the use of permanent wage labour have found to have a significant influence on the development of organic shrimp aquaculture in Bangladesh. Organic farmers are earning significantly higher income from shrimp due to higher production, lower production cost and higher market price. It can be concluded that the contribution of organic shrimp is positive for farmers in Bangladesh, and can be inspired policy maker to develop strategies towards sustainability of shrimp sector.

Keywords: Aquaculture, Bangladesh, organic, shrimp

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The Parasites of Cultured and Feral Nile Tilapia (*Oreochromis niloticus*) in Umudike, Nigeria

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Fifty eight specimens of Nile tilapia (*Oreochromis niloticus*) were collected between the months of August and November with the use of siene net from the culture ponds of Michael Okpara University of Agriculture, Umudike and the water reservoir of National Root Crops Research Institute, Umudike impounded from Ohii Stream. Vital morphometric data of the specimens were recorded with the aid of calibrated metre rule while visual examination of the external part of the fish specimens were carried out immediately with the naked eye and hand lens for ectoparasites. This was followed by dissecting the specimens to obtain the internal organs which were properly labeled and preserved in 4 % formalin for further examination. The preserved organs were subsequently sliced separately into piece, mixed with water and examined under stereo microscope for endoparasites. The recovered parasites were placed on covered slides and examined under the light microscope. The parasites obtained from each specimen were then properly counted and classified. No significant difference was observed in the level of parasitic infection between the pond cultured (89.65 %) and the wild (93.10 %) *O. niloticus*. This may be because both the ponds and reservoir have Ohii Stream as source of water. Trematodes, Cestodes and Copepods were the major parasites found on *O. niloticus* from both habitats. Trematodes and Cestodes constituted 48.8 % and 41.38 % respectively for cultured *O. niloticus*, while the feral *O. niloticus* had 13.8 %, 17.2 % and 62.0 % Trematodes, Copepods and Cestodes respectively. The Cestodes were found in the intestine of *O. niloticus* while the Trenatodes and Copepods were found on the gills. Among the size groups 10–15 cm in the culture ponds had the highest occurrence of Trematodes (24.14 %) while 5–10 cm class of feral habitat had the highest occurrence of Cestodes (58.62 %). Similarly 5–10 cm class of reservoir *O. niloticus* had the highest (10.34 %) infection of Copepods.

Keywords: Cestodes, Copepods, Nile tilapia, parasites, trematodes

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Bacteriological Assessment of Poultry Water and Effect on Mortality and Egg Production of Caged Layers

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Water plays an important role in regulating the body temperature,transport of nutrients and hormones,digestion of food and removal of wastes from the body. Unfortunately, both the quality and quantity of the water provided for livestock are often overlooked. It is essential to maintain clean water sources due to high dependence of poultry birds. This study was carried out to assess the mortality and egg production of caged layers in relation to the bacteriological analysis of their drinking water. 324 harco layers, aged 77 weeks were randomly divided into three groups (open, nipple and control). Three birds were randomly assigned to each cell and each group comprised of 36 birds with two replicates. Records of egg weight, egg production and mortality were obtained daily. 18 water samples were randomly collected from source (borehole), storage tanks (open/drinking trough and nipple drinkers) between January and March 2010. The bacteriological examination of the water samples included the most probable number of presumptive coliforms. The results showed that the total coliform counts (MPN/100 ml) was zero in all samples taken from borehole and the closed overhead tank outside the pen, while coliforms were detected in water samples from open storage tanks within the pen, as well as those samples from the open and nipple drinkers. Chickens provided with water in open troughs laid more eggs, and on the whole produced heavier eggs than those chickens supplied with water via the nipple drinking system.
In contrast, mortality due to diarrhea diseases were more frequent in birds watered by open drinking system. In a resource scarce location, where people do not have the required expertise, open drinker system may be practised with necessary precautions such as routine treatment of the water with sanitisers such as chlorine and benzalkonium chloride.

Keywords: Bacteriological, coliform, egg, mortality, poultry

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An Assessment of Genetic Potential of Vietnamese Local Pig Breeds for Sustainable Use of Pig Genetic Resources in Vietnam

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In Vietnam, national programs on conservation of the Vietnamese local animal genetic resources have been initiated since 1990. Thanks to these programs, many local breeds are being conserved and developed. Local pigs are the country's most important meat source and play an integral role in the smallholder farming systems. There are 12 Vietnamese local pig breeds (http://dad.fao.org) which are kept throughout the country from the North to the South. They present a high diversity of phenotypes. They are assumed to be adapted with the local harsh environment and their meat is tasty. However, research on genomic variation and major genes with relevance to their special traits is limited. Beside phenotypic characterisation, assessment of genetic characterisation of Vietnamese local pig breeds is a prerequisite for the purpose of sustainable use of animal genetic resources. Following the national animal genetic resources conservation programs, Vietnamese government has funded a project to assess genetic potential of Vietnamese local pig breeds. Three traits (growth, litter size and meat quality) of local pigs will be analysed at both levels which are an evaluation of genetic parameters and an analyse of candidate genes. Modern animal breeding and selection which is based on genetic evaluation using Henderson's Mixed Model Methodology (MMM) to estimate the estimated breeding value of the individual will be used. Three genes of topituitary-specific transcription factor-1, myogenin and gene heart fatty acid BP related to growth rate, two genes of estrogen receptor and prolactin receptor linked to litter size, and two genes of Halothan and Rendement Napole connected to meat quality will be determined. This comprehensive study combining two methods will provide valuable information for sustainable conservation, use and exploitation decisions of Vietnamese local pig genetic resources.

Keywords: Genetic potential, Vietnam, vietnamese local pig

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Developing Predictive Equations for Pig Body Weight from Linear Body Measurements at Different Phases of Growth

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48 pigs were used for 12 weeks to determine the relationship of various linear body measurements- Body length (BW), Body length (BL), Loin circumference (LC), Heart Girth (HG), Tail length (TL), Height at wither (HAW), Hoof length (HL), Hoof height (HH), Head length (HDL) and Head width (HW) to Sex and body weight of pigs. 16 pigs each at different growing phase Weaners, Growers and Finishers- males and females were measured. BW was taken using a circular scale and linear body measurements were taken using measurement tape and Venier caliper on weekly basis. Pigs were kept under the same feeding and management conditions. Data obtained were subjected to T-test analysis and Regression analysis. Results showed that for Weaner and growing pigs there was no effect of sex on the BW and linear body measurements. But for the finishing pigs sex had effect ($p < 0.05$) on BW and linear body measurements.

The BL, LC, HG, HAW and HL of Weaner and growing pigs were found to be significantly ($p < 0.05$) related to BW of pigs. But BL, HG and HAW only were found to significantly ($p < 0.05$) related to the BW of finishing pigs. HAW and HG were found to be better predictor of body weight at the weaner phase, while HG and BL were found to be better predictors of BW in growing pigs than other linear body measurements. HG and BL were also found to be better predictor of BW in the finishing pigs than other linear body measurements.

Higher prediction of body weight from the linear body measurements was achieved when data from the different phases of growth were used to derive a predictive regression equation relating the different body measurements to body weight of pigs. With the Heart girth giving a better prediction of 91.8 %, than body length (89.9 %), Loin dimension (88.2 %) and height at wither (83.2 %). The developed equations can be used to determine the weight of pigs in order to reduce the stress of weighing very large pigs; and when weighing scale is either in-accurate or un-available, which is the situation with some farmers in most developing countries.

Keywords: Body weight, linear body measurements, pigs, predictive equations

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Documenting Normal Microflora in *Thrynomyns swinderanus*: Towards Accelerated Domestication of Emerging peri-Urban micro-Livestock

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Grasscutter meat is widely recognised as a source of animal protein in many West African countries, particularly, Ghana, Benin, and Côte d'Ivoire. Despite the apparent potential of the grasscutter, attempts made to domesticate it have been hampered against by high mortality caused by diseases and nutritional factors, resulting in over reliance on the wild populations. It is in this light that this work seeks to initiate a novel chapter in the study of the grasscutter by first documenting its intestinal microflora for health and nutritional exploration. Thirty-six healthy grasscutters (neonates, weanlings, subadults and adults) for a period of six months, were examined for gastrointestinal tract (GIT) cultivable normal microflora using the culture method. The normal GIT microflora isolated in the 1-week, 2-week, 3-week and 4-week old grasscutters were similar in composition and they comprised: *Staphylococcus species*, *Bacillus* species, *Bacillus cereus*, *Escherichia coli* and *Klebsiella* species in the aerobic cultures. *Peptostreptococcus* species and Bacteroides species were identified in the anaerobic cultures. Unexpectedly, *Candida albicans* grew profusely on both aerobic and anaerobic cultures throughout the one month life of the neonates. Analysis of the weanlings, subadults and adults showed that GIT microflora had similar composition as that of the neonates but also had in addition, *Enterobacter* species from the aerobic cultures, and *Corynebacteria* species and *Clostridium perfringens* from the anaerobic cultures. The sex of grasscutters did not constitute any statistically significant source of variation in the populations of the cultivable aerobic GIT normal microflora. The age of the grasscutter significantly influenced the populations of all cultivable aerobic GIT normal microflora identified ($p < 0.01$) except for the staphylococcus species. The study identified varying levels of correlations both negative and positive among populations of the cultivable aerobic GIT normal microflora, except *Enterobacteriaceae* and *Bacillus cereus* that were not correlated. *Bacillus cereus* isolation particularly is of significance as it is a documented causative organism of food poisoning in humans. The findings of this novel study will provide the impetus for meaningful studies into microbial disease and the possible use of probiotics to enhance the performance of grasscutter in captivity.

Keywords: Cultivable, intestinal, microflora, probiotic

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An Appropriate Crossbred Pig for Natural Farming System in Thailand

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Appropriate breeds for natural farming system were chosen to study the production efficiencies. Five crossbred pig breeds (n=10 per breed) of 1) Duroc × Large White × Landrace (DU × LW × DR) , 2) Pietrain × Large White × Landrace (PT × LW × LR;), 3) Duroc × Meishan (DU × MS;), 4) Pietrain × Thai native (PT × NT), and 5) Thai native pigs (NT;) were fed with fermented feed in the Han Kyo Cho's natural farming system. In the fattening periods (30 to 60 and 60 to 100 kg), the ADG of DU × MS was significantly higher than those of the other breeds ($p < 0.05$). The FCR and FE were significantly ($p < 0.05$) higher in DU × MS and NT but NT had the longest growing period (167 days) while Du × MS had the shortest period (101 days). The average daily gain of the other European crossbreds showed no significant differences. Therefore, DU × LW × DR has higher ADG and PT × LW × LR was superior in FCR and FE. No significant differences between the production efficiencies of the crossbred DR × LW × LR in the commercial system (n=10) compared to the same breed in natural system during 12 to 30 kg, whereas, higher ADG, FE and better FCR ($p < 0.05$) of the DR × LW × LR (30 to 60 kgs) were found in the commercial system. No significant differences were found in the period of 60 to 100 kg between the two systems but the pigs in the commercial system had a 25 days shorter fattening period. The analysis of carcass quality showed higher carcass length and low back fat thickness (BF) in the European crossbreds (DUxLWxDR and PT×LW×LR) compared with the native lines (PT× NT and DU × MS) raised in the natural farming system. Therefore, the native lines showed significantly higher values for redness (a*) and yellowness (b*) ($p < 0.05$). Lightness (L*) was significantly ($p < 0.05$) higher for the DU×LW×DR in the commercial system compared to DU×LW×DR in the natural system while the pigs in natural farming systems had increased in a* and b* values.

Keywords: Natural farming, swine, Thailand

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Evaluation of Pig Management and Breeding under Different Smallholder Production Systems

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This study analysed the existing pig management and breeding practices of smallholder farmers under different production systems geared towards the development of breeding objectives and design of pig breeding programmes in Kenya. The two distinct systems evaluated included semi-intensive system and extensive system and they differed in remoteness, market access, resource availability and pig production intensity. Data were collected using structured questionnaires where a total of 102 pig farmers were interviewed. Qualitative and quantitative research methods were employed to define the socioeconomic characteristics of the production systems, understanding the different roles that pigs play and identifying the breed and trait preferences that determine genetic selection. The results show that regular cash income and insurance against emergencies were the main reasons for rearing pigs. Finances, feeds and housing were identified as the major constraints to production. The farmers identified the following breeding objectives: high body weights, big size, high growth rate, prolificacy, piglet survival and disease tolerance. The breeding objectives can be achieved through the development of village breeding programmes whereby farmers in the semi-intensive system should focus more on production and reproduction traits, while maintaining functional and adaptive traits. In the extensive system such programmes should focus on adaptive traits such as utilisation of fibre-rich diets and disease tolerance. For the improvement of pigs in Kenya and other countries in the tropics, this study concurs with other studies that there should be concomitant development of feeding strategies based on cheap locally available feedstuffs, simple, affordable and relevantly designed pig sties, proper disease control and health management and the identification of suitable traits that fit local environmental conditions.

Keywords: Breeding objectives, Kenya, pigs, production systems, smallholder

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Estimating Live Body Weight of Indigenous Chickens Will Help Rural Farmers Negotiate Equitable Prices of Birds in Uganda

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Zoometrical measurements and their relationship with live body weight were determined in indigenous chicken of the Lake Victoria Crescent agro-ecological zone in Uganda. The effect of age and sex was significant ($p < 0.01$) for all measurements. No effect of plumage was observed ($p > 0.05$). Males showed higher live body weights and other body measurements than their female counterparts ($p < 0.01$) while all body measurements, increased with age. An average mature male chicken weighed 2.11 ± 0.27 kg while a female weighed 1.48 ± 0.15 kg. Correlation coefficients between body weight and other measurements were high and positive ($p < 0.01$) except for body length and femur circumference in females. Chest circumference was the best single live weight estimator (r = 0.88) closely followed by body length (r = 0.81), and femur length (r = 0.80) while femur circumference (r = 0.29) was the least. Prediction of live body weight from chest circumference using the power model ($R^2 = 0.83$) was the most reliable compared to simple linear regression (0.76) and polynomial ($R^2 = 0.77$). The strong relationship between live body weight and other body measurements could be exploited to increase the ability of poor resource and rural farmers to negotiate prices of their birds using measurable indicators. Live body weight estimate measurements (especially chest girth) were tried out in three selected rural markets, as a basis for determining the chicken price. It was observed that there was a strong relationship between the price agreed upon, by visual observation and that of estimating body weight using zoometrical measurements. Further research was recommended to accumulate enough data that would be used for policy advice to always use live body weight estimate as a basis for setting prices of rural chicken, where appropriate equipment is lacking.

Keywords: Chest girth, economic value, marketing, zoometrical measurements

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The "Awudu Heater": An Appropriate Solution to Brooder House Thermal Environmental Control for Poultry Farmers

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Inadequate provision for thermal environmental control contributes to high chick and guinea fowl keet mortality in the smallholder poultry production sector. The "Awudu Heater" is introduced to address this problem to a large extent. The heater is simple, portable, accessible and easy to make at the rural level. It runs on wood charcoal and costs just twenty Ghana Cedis (GH¢20.00 $\approx$ \$ 30.00). The main components of the heater are ordinary clay and pebbles. The heater was tested in an enclosure 2.5m $\times$ 1.5m $\times$ 2.5 m (length $\times$ breadth $\times$ height) and its performance compared with that of gas, electric bulb (incandescent/onion bulb) and kerosene powered heaters. Temperatures were measured at distances of 3, 6, and 10 cm respectively from ground level and at radial distance intervals of 20 cm from the heater. Readings were taken at 15 minutes interval for a period of 24 hours for one week on each treatment. The quantity of charcoal used was measured at intervals of 12 hours. Results showed that 500g of charcoal maintains a minimum average temperature of 37°C for a period of 12 hours (day time) and 35°C for a period of 12 hours (night time) on measured distance 3 and 6 cm respectively. Minimum average temperature of as low as 25°C was recorded for measurements 10 cm above the ground. As compared to kerosene, gas and electric bulb heating, the "Awudu Heater" is found to be 5 times, 15 times and 10 times cheaper respectively. The heater is being adopted by farmers in the Northern and Upper East Regions. Within six months of its introduction two hundred units are being used in these regions by individual farmers, as well as farmers adapted by Animal Research Institute (ARI), the German International Cooperation (GIZ) and New Energy – a local NGO.

Keywords: "Awudu heater", ordinary clay, pebbles, thermal environment, wood charcoal

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Growth of Pigs Fed with *Brachiaria* Hybrid Mulato II × *Cratylia argentea* Meal as Protein Supplement

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Gramineous or legume foliages such as *Brachiaria* hybrid Mulato II and Cratylia argentea are tropical perennial species interesting for pig nutrition, because of their yield and protein content. These plants have been studied in ruminant animals but not in monogastric species. The aim of this experiment was to assess the productive behaviour of pigs fed with a mixed forage meal of Cratylia and Mulato II (1:1) as protein supplement in the phase of 85–110 kg live weight.

The trial took place on the experimental farm of the National University of Colombia, Palmira. The foliages were harvested before flowering, sun-dried and milled to 3 mm mesh size. Fifteen commercial female pigs of 84.5 kg initial weight were utilised for the experiment. It was a completely randomised block design with 3 treatments and 5 replicates. The 3 diets were Control, mixture of Cratylia and Mulato replacing 15 % of the crude protein (CP) contributed by soybean meal, and Cratylia and Mulato mixture, 30 % CP replacement.

As result, the variables consumption (2.39, 2.36 and 2.3 kg DM/day resp.) and daily feed consumption in terms of g DM per kg of metabolic live weight (LW0.75) (85.8, 79.9 and 85.2) were similar for the treatments ($p > 0.05$). Daily live weight gain (LWG 0.768, 0.631 and 0.614 g) and feed conversion (FC 3.19, 3.63 and 4.00) did not show significant differences between treatments ($p > 0.05$).

No differences were observed in the digestive tract in pH of stomach, duodenum ileum, cecum and colon between treatments. The carcass parameters showed no significant differences (rate of carcass yield, backfat, back pH, carcass temperature, colour and loss by dripping), although higher forage inclusion (33 % of the diet) showed an interesting tendency to less fat content and loss by dripping. The inclusion of a Cratyilia and Mulato mixture as herbage meal of up to 33 % of the total diet is regarded as a viable option for pigs in the final growing phase.

Keywords: *Brachiaria* hybrid, *Cratylia argentea*, herbage meal, pig, protein supplement

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Development of SNP Markers for Individual Identification in Thai Native Chicken

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Individual identification using DNA markers are essential for traceability and management in animal production. Animal identification has been reported in cattle and pigs. However, information on molecular markers for individuality of chickens is limited. The objective of this study was to develop the single nucleotide polymorphism (SNP) markers for genetic individual identification in Thai native chicken (Praduhangdam). An Amplified Fragment Length Polymorphism (AFLP) technique was performed to identify candidate SNP markers. A total 139 polymorphic bands were obtained from 64 AFLP primer combinations. From these markers, 30 AFLPs were converted into single nucleotide polymorphism markers for genotyping. One hundred individual Praduhangdam chickens were genotyped with Polymerase Chain Reaction-Restriction Fragment Length Polymorphism (PCR-RFLP) technique. The allelic frequencies of each SNP marker were estimated. Based on the frequency data, the Hardy-Weinberg equilibrium (HWE), polymorphism information content (PIC) and probability of identity (PI) of markers were analysis. Sixteen markers were found in HWE. PIC values of markers were 0.1–0.4 and the PI value was 8.49×10^{-9}. Thus, the change of a coincidental genotype match between 2 chickens was 1 in 117 million. Moreover, 16 highly informative SNP markers provided the PI value of 8.52×10^{-7} or 1 in 1.1 million. These markers demonstrated a minimal set of SNP with sufficient power for individual identification of chickens. The results in this study indicated that the developed SNP markers could be useful for discriminating the individuality of Praduhangdam chicken breed. Knowledge of these study provides a powerful approach for traceability in poultry and livestock species.

Keywords: Individuality, SNP markers, Thai native chicken

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Characterisation of Performance Traits and Management Practices of Omani Local Chickens

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A characterisation of local chicken types and their mostly rural production systems is beneficial for designing and implementing development and conservation programs. In Oman, conservation programs for local breeds of different livestock species are currently started. This study was conducted to identify the socio-economic conditions and management practices of small-scale chicken keepers and to evaluate the birds' production traits. Using a structured questionnaire, data were collected in 163 households from 18 villages distributed across Oman's six major agro-ecological zones (Musandam, Batinah Coast, northern Hajar, eastern Hajar, eastern Coast, Dhofar). Purposes of keeping local chickens were egg production (68.8 %) and income generation (31.2 %). Flock size averaged 23.6 (SD 8.33) chickens per household with 4.8 hens per one cock. Clutch size was 13.6 eggs (SD 2.47) and annual egg production was 71 (SD 7.25) per hen. Egg hatchability was 88.1 % (SD 5.87) and annual chicken mortality across all age and sex categories was 16.3 % (SD 1.37). Predators were a major cause of loss for 56.5 % of the respondents, 30 % reported health problems, mainly respiratory and mucosal diseases (18.2 %). The main selection criteria adopted by farmers were egg production per clutch and body size. Chickens were mostly owned by adult women and children (76.8 %). The majority of chicken owners had no knowledge of modern chicken management and breeding (69.1 %), whereas 30.9 % had received instructions from extension agents. All family members and even hired labour were involved in chicken management. Free-range scavenging dominated (79.7 %), and only 20.3 % households purchased supplement feed for their chickens. Females and children mostly took care of daily feeding, watering and egg collection (74.4 %). Adult males and hired laborers were responsible for slaughtering chicken (86.3 %) and maintenance of the chicken house (88.8 %), which in most cases (76.9 %) was made from local materials such as straw, palm leafs and mud bricks. Logistic regression analysis showed that literacy of chicken owners was related ($p < 0.05$) with better feeding, housing, and health care of the chickens. Improving the productive traits of the local chicken types and the specific knowledge and skills of their owners can effectively advance chicken production in rural areas of Oman.

Keywords: Egg production, livestock conservation, rural smallholders, scavenging system, task division

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Some Aspects of Camel Raising in the Butana Area of the Sudan

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Information concerning management, feeding, nutrition and production performance of camels are scanty. The overall objective of this study is therefore to probe the changes in herds and their structure specially herd population with regard to breeds, the current production system; production performance and constrains that hinder camel production in Butana area of Sudan. A well planned questionnaire was designed for the purpose of study. A follow up for one year of milk production in open grazing system (migratory) and semi open grazing system (sedentary) was carried out. The results obtained showed three production systems, the nomadic migratory 22 %, semi-nomadic 36 % and the sedentary production system 42 %. It also reflected a negative decrease (-10.97) in camel herd population under migratory system and a positive increase of (5.2 %) in camel herd population in sedentary system. Milk yield per lactation for migratory was 1654.4 kg and 2925 kg for the sedentary system. The mean herd size was 62 head for migratory and 118 for sedentary, with male to female percentage of 25.6 % and 74.4 %, respectively. Irrespective of sex, age wise less than one year represented 14.4 % of the herd, less than 4 years 23.9 %, less than 14 years 48.9 % and above 14 years was 12.9 %. The practice of the nomadism by the herders showed a decrease along years 1984, 1994 and 2003 with percentage of 73.3 %, 33 % and 22 %, respectively. Each year is independent of the other and not on an additive basis. The results reflected illiteracy among herders groups of age (15–29 years) was 47.8 % and for (30–49 years) was 67.7 % and for (above 50 years) old was 67.7 %. The study revealed that the migratory system is no longer highly profitable for camel production where the yearly expenditure was exceeding the yearly income. The constrains of camel production include natural disasters as drought and man made halters as encroachment of mechanised agriculture on pasture, insecurity and tribal conflicts and wars.

Keywords: Butana area, camel production, grazing system, herd population

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Animal nutrition

The Seasonal Contribution of Trees and Shrubs to Cattle, Sheep and Goat for Different Climatic Zones in Burkina Faso, West Africa

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Across the West African Sudano-Sahelian zone, woody plants are frequently browsed by domestic ruminants. Most tree and shrub species maintain green leaves and a high nutritional value throughout the dry season, when grasses deteriorate both in quality and quantity. However, anthropogenic pressure and climate change affect the survival and regeneration of trees and shrubs. This study determined the seasonal preference of cattle, sheep and goats for different woody species across three agro-ecological zones of Burkina Faso, and the ethno-veterinary uses of these plants by livestock keepers. From February 2009 to August 2010, selection behaviour along daily grazing itineraries was determined by regular manual observation and GPS-tracking of one cattle and one small ruminant herd each in four different villages. Uses of ligneous plants for livestock feeding and disease treatments were assessed by structured interviews with 75 livestock keepers. Selection of a total of 75 woody species from 24 botanical families was recorded across the four study locations. Preference varied between livestock species, season and location. Cattle strongly preferred *Afzelia africana, Pterocarpus erinaceus, Piliostigma thoningui, P. reticulatum* and *Dichrostachy cinera*, while sheep and goats primarily fed on *Balanites aegyptiaca, Ziziphus mauritiana, Acacia seyal, A. dudgeoni, A. gourmaensis, Piliostigima thoningui* and *P. reticulatum*. Across the yearly cycle, browsing time ranged from 19.9 to 36.9 % of daily eating time in goats, 3.5 to 19.2 % in sheep and 0.5 to 15.1 % in cattle, with insignificant differences between agro-ecological zones. About 70.7 % of interviewed livestock keepers relied on ethno-veterinary practices for treatment of sick animals, and more than 36 woody species were mentioned to be used in counteracting the 13 most frequent diseases of cattle and small ruminants. Leaves, bark, and flowers, respectively, of (1) *Vitelaria paradoxa*, (II) *Khaya senegalensis* and (III) *Balanites aegyptiaca* were used against snake bites as well as diarrhea (I), trypanosomiasis (II), and retention of placenta (III). Given the important roles of woody species for livestock feeding and health care, forecasts on how climate change might affect their occurrence and abundance are needed so as to allow livestock keepers develop adaptive strategies in anticipation.

Keywords: Browse, ethno-veterinary use, forage selection, grazing time

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Tropical Forages to Enhance Productivity of Monogastric Animals with Low-Income Farmers in Nicaragua and Honduras

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Monogastrics (*e.g.*, swine, poultry) are important for family nutrition and income of smallholder farmers and often managed by women. Scarcity of high-quality (protein) feed is the main constraint to production and market competitiveness. Typically feed of low nutritional value in combination with costly cereal-based concentrates is used, causing a direct competition of monogastrics with humans.

This research identifies and tests potentially suitable high-quality forage-feed resources for integration within smallholder production systems in Nicaragua and Honduras.

In a first stage, the agronomic characteristics of herbaceous forage legumes, including accessions of *Vigna unguiculata*, *Lablab purpureus*, *Clitoria ternatea* and *Stylosanthes guianensis*, were determined and among the most promising were *Vigna unguiculata* CIAT 4555 and *Lablab purpureus* CIAT 22759.

In a second stage, the effect of partly substituting concentrates by fresh foliage of these legumes was assessed in 19 on-farm feeding trials. At each farm three pigs of the same sex and litter received each one of three treatments: 0 % (control), 25 % and 50 % substitution of sorghum/maize by forage, the latter harvested daily at flowering stage with fresh supply guaranteed by planting small plots (100 m^2) at weekly intervals.

Daily average live weight gain was 140 g per animal without significant differences between the treatments;no differences between sexes were found neither. Initial live weight, however, had an important effect: animals over 15 kg grew 220 g day^{-1}, in comparison to less than 100 g for smaller pigs.

In spite of the relatively low performance, results are promising and imply that at typical farm production level substitution of up to 50 % of concentrate by forages does not affect productivity and leads to a decrease in costs if the extra labour - mostly provided by the family - needed for forage production (less than an hour per day) is not taken into consideration. In ensuing experiments only animals over 15 kg will be included, as smaller pigs are not capable to efficiently utilise forages with a relatively high fiber content. Furthermore, silages will be included and production level will be enhanced by the addition of some locally available ingredients with higher nutritive content.

Keywords: Central-America, herbaceous forage legumes, monogastrics, smallholders

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Farmers Innovations in Livestock Feeding and Management in semi-Arid Areas of Ethiopia

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This study was conducted in Meiso district located 300 km east of Addis Ababa. Most of the district has an elevation of about 1700 m asl and is surrounded by a chain of mountains. Mean annual temperature is around 21°C, while average annual rainfall ranges from 635 to 945 mm. The district has mixed crop-livestock, agropastoral and pastoral production systems. Sorghum, maize, sweet potato, chat and vegetables are the major crops grown and cattle, goats and camels are the dominant livestock species. The rainfall is erratic and unreliable, often resulting in recurrent drought and hence relief aid is a regular source of livelihood for many rural families. Crop failure and shortage of feed are the most limiting factors for development in all the farming systems. This is aggravated by climate change as manifested by reduced biomass productivity due to shortage of rainfall, shrinkage in grazing land, water shortage and loss of biodiversity. This paper explains and discuses innovative adaptation mechanisms developed by farmers in both crop production and livestock rearing systems to cope with food and feed deficits. The farmers' innovations include a) change in cropping system - intercropping sorghum with sweet potato and beans to increase food and biomass yield, cultivating sole maize or sweet sorghum for animal feed, application of manure on farm land on regular basis; b) change in feed production and conservation - enclosing pasture lands and with some rehabilitative measures, timely collection of crop residues and tillers of sorghum, hiring enclosures on temporary basis, exchange animal feeds for draught power, establishing grass strips on farm bunds; c) improving nutritive value of feed resources by applying fresh urine and salt on roughages; d) change in feeding systems - use of locally available mineral soils, use of cereal grain as supplementary feeds with different forms of presentation such as roasting, boiling, heat treatment of cactus leaves and roots prior to feeding animals, grinding, malting, dehulling; e) use of local herbal medicines as part of fattening animals; and f) complete shift in animal management to cut and carry feeding system, and use of spate water harvesting for irrigation.

Keywords: Ethiopia, farmer innovation, feeding systems, livestock

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Carbohydrates – A Trait to Indicate Sustainable Grazing Practice in semi-Arid Grasslands?

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Adequate carbohydrate reserves in underground organs of perennial grasses are crucial for winter survival, drought tolerance, spring growth initiation, and regrowth after herbage removal and therefore an important trait of ecosystem resilience. Most natural grasslands are used for livestock keeping, but our understanding of how belowground carbohydrate dynamics respond to different grazing intensities is still limited, although this parameter might have the potential to function as a proxy for sustainable land management and ecosystem health.

In the northern Chinese semi-arid grasslands we analysed soluble carbohydrates and the different sugar components of two dominant grass species, representing the functional plant types of rhizome grasses (*Leymus chinensis*) and bunch grasses (*Stipa grandis*) at three sites representing different management practices: a long-term grazing exclosure (UG), a moderately winter grazed site (WG) and a heavy grazed site (HG).

The results showed that total soluble carbohydrate (TSC) in the underground organs of *L. chinesis* and *S. grandis* increased and then declined with increasing grazing intensity. The rhizomes of *Leymus* had highest TSC at site WG. Generally *Leymus* stored a higher amount of soluble sugar in the belowground organs than *Stipa*, indicating that plant functional types (bunch and rhizome grass) responded differently to grazing. Fructan, sucrose, glucose and fructose were important soluble sugar components for both species. Fructan and fructose accounted for more than 80 % of TSC. For *Leymus*, TSC and the four sugar components in the roots were lower than that in the rhizome, demonstrating that rhizomes served as the main underground sugar-storage organ. Our results indicate that moderate winter grazing effectively contributes to the accumulation of soluble carbohydrates, and TSC can be used as potential indicator of sustainable land use.

Keywords: Grazing intensity, Mongolia grassland, *Leymus chinesis*, *Stipa grandis*, soluble carbohydrates

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Blood Profile of Brolier Finishers Fed Graded Levels of Indomie Noodle Waste Meal in Humid Tropics

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High cost of energy source animal feed ingredients specifically maize in the tropics has pushed animal nutritionists and livestock farmers into utilisation of cheaper alternatives without detrimental effect on the performances and physiological responses of these animals. Indomie Noodle is a popular fast food product well accepted by households in the tropics especially Nigeria. The factory wastes during the manufacturing process is usually enormous. It is being used in view of its high metabolisable energy, ether extract and crude protein contents to replace maize in the diets of brolier chickens both at starter and finisher phases with good results in terms of growth responses and cost implication. However, there is paucity of information on the physiological responses of these birds which can be assessed among other things by the blood profile to its incorporation.

One hundred and fifty unsexed Hypecco strain of broilers were randomly allotted into five isocaloric and isonitrogenous dietary groups with graded levels of Indomie Noodle Waste Meal at 0% (control), 25 %, 50 %, 75 % and 100 % to replace maize. Each group had thirty birds with three replicates in a completely randomised design. Dietary treatment started at the 5^{th} week of age and lasted for five weeks while blood collection started at 5^{th} shortly before the commencement of the treatment and weekly thereafter. Haematological parameters investigated were haemoglobin concentration (Hb), packed cell volume (PCV), white blood cell count (WBC), red blood cell count (RBC) while erythrocyte indices were calculated. Serum metabolites analysed for were total protein (TP), albumin, globulin, uric acid, calcium, glucose, creatinie, bilirubin and total cholesterol (TC). Data generated were subjected to statistical analysis of variance.

Hb, PCV and the erythrocyte indices were significantly ($p < 0.05$) lowered by the IWM inclusion but not adversely while serum TP, albumin, globulin, calcium and TC were significantly($p < 0.05$) elevated with the level of IWM inclusion in the diet.

IWM can be used to replace maize in the diet of broiler finisher chickens the level of which must not exceed 50 % to avoid high level of serum toltal cholesterol.

Keywords: Blood profile, broiler finisher, humid tropics, indomie noodle

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Protein and Energy Digestibility of Selected Aquatic Macrophytes Treated by Sun Drying and Lactic-acid Fermentation for the Amazonian Fish *Piaractus brachypomus* (Cuvier, 1818)

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The South American red pacu (*Piaractus brachypomus*) is an omnivorous fish with a predominantly herbivorous-feeding behaviour. It is the primary fish species in the national programme of food safety in Colombia and occupies the second place in the national aquaculture production. To reduce feed costs in red pacu cultivation and therefore to ensure small-scale farmer's income in the marginal areas of the Neotropics, the use of non-conventional feed sources for this species should be tested. Aquatic macrophytes are one of the most abundant plant materials in the Neotropical floodplain systems and a natural feed source for native fish. However, information on the nutritional value of aquatic macrophytes for red pacu is lacking. As the apparent digestibility coefficients (ADCs) provide valuable information for the formulation of nutritional and economically feasible diets and for the preservation of the aquatic environment avoiding the accumulation of indigestible ingredients in the water, the ADCs of crude protein ($ADC_{protein}$) and the gross energy (ADC_{energy}) of sundried and fermented aquatic macrophytes (*Spirodela polyrhiza, Lemna minor* and *Azolla filiculoides*) for juveniles (31.0 ± 5.2 g) of *Piaractus brachypomus* were determined. In this study each test ingredient was included at 300 g kg^{-1} the reference diet were 97.2 % and 70.1 %, respectively. $ADC_{protein}$ and ADC_{energy} of the tested macrophytes were significantly different between plant material types and processing methods, but not between their combinations. $ADC_{protein}$ ranged from 74.9 % to 84.5 % for fermented macrophytes and from 51.1 % to 60.4 % for sundried macrophytes, indicating that the fermentation affected positively the protein digestibility of the plant material ($p < 0.05$). Among the plants, fermented *Spirodela polyrhiza* showed the highest $ADC_{protein}$. The sundried aquatic macrophytes would not be recommended as exclusive nutrient sources. However, the fermented aquatic macrophytes can be recommended as supplementary protein source in practical diets for *Piaractus brachypomus*.

Keywords: Amazonian fish, aquatic plants, fermentation, nutrients digestibility, sun drying

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Biodegration of whole Leaves of *Enterolobium cyclocarpum* by *Aspergillus niger*

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In the tropics, native pastures and crop residues constitute the major feed resources for ruminants. There are available seasonally and of low quality. They contribute to the limitation of ruminant production which is predominantly managed by small holders. *Enterolobium cyclocarpum* (EC) is a hardy multipurpose tree (MPT) that has potential as supplement for ruminant feeding. However, antinutritional factors (ANFs) contained in the leaves of EC could have negative effects on its nutritive value. Fungal biodegradation by solid- substrate fermentation (SSF) of four ANFs namely: tannin, saponin, phytic acid and oxalate in leaves of EC was investigated. *Aspergillus niger* was used to inoculate whole leaf samples of EC. The levels of ANFs in the leaf substrates were estimated after 0, 7, 21, and 28 days. Inoculation of the whole leaf samples of the EC with *Aspergillus niger* caused reductions in the ANFs. Percentage reduction in EC was 42.7 %, 28.7 %, 25.6 % and 26.5 % for tannins, saponins phytic acid and oxalate, respectively. *Aspergillus niger* significantly ($p < 0.05$) increased crude protein levels in the leaves of EC up to day 14 beyond which there was no further significant increase. Ether extract values decreased from day zero to 28 days after fermentation. EC contained less acid detergent fibre (ADF) at day 7, 14, 21 and 28 than at day 0. Results from analysis of neutral detergent fibre (NDF) showed a decrease as the period of fermentation increased. *Aspergillus niger* caused significant improvement in substrate nutrient composition. This study showed the importance of fungal fermentation in improving the nutritive value of MPTs. Protein enrichment and simultaneous degradation of fibrous fractions (ADF and NDF) and ether extract were observed. In addition, antinutritional factors: saponins, phytic acid and oxalate were reduced though at lower relative percentages compared to tannin.

Keywords: Antinutritional factors, biodegradation, *Enterolobium cyclocarpum*, fermentation, leaves

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Precipitation Ability of different Tannin Extracts for BSA at Variable pH Values i*n vitro*

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Tannins are known to form complexes with proteins at rumen pH conditions. These complexes are not available for rumen microbes, but may dissociate in the abomasum due to the low pH. The objective of this study was to determine the ability of quebracho (*Schinopsis lorentzii*), mimosa (*Acacia mearnsii*), tara (*Caesalpinia spinosa*) and gambier (*Uncaria gambir*) extracts to precipitate bovine serum albumin (BSA) *in vitro* at six pH values between 7 and 2.

Increasing amounts of each extract (up to 10 mg extract) were added to sodium-acetate-buffer with 1.5mg BSA ml^{-1}. Precipitated protein was measured by the Bradford colour reagent method. For each combination of extract type and pH value data were fitted to a log-logistic equation: $f(x) = 0 + d/1 + exp\,(b(log(x) - log(e)))$. Parameter *d* equals the maximum precipitation (plateau), and *e* equals the amount of extract when 50 % of d was reached (ED50).

Results show large differences in the BSA amount precipitated among the different extracts and in combination with pH values. Tara showed questionable plateau values, higher than the amount of BSA in solution, which may be related to interactions with the colour reagent.

Mimosa precipitated all BSA, independent of pH value. Mimosa achieved higher plateaus than quebracho ($p < 0.001$), except for pH 7. Tara plateaus were comparable to mimosa, except for pH 3 and 6. Gambier often did not achieve plateaus for the amount of extract weighed. Comparing different pH values within extract, quebracho plateaus increased up to pH 4 ($p < 0.0001$). Increase of mimosa plateaus was only significant between the lowest and the highest pH values. Increasing pH value did not influence plateaus for tara and gambier ($p > 0.05$). Less quebracho was necessary to reach ED50 than tara at pH 6 and 7, or gambier at pH 3 and 5, or mimosa at pH 3. However, more quebracho was necessary than mimosa at pH 6 and 7 ($p < 0.01$).

In conclusion, stepwise pH change from 7 to 2 hardly influenced the precipitation ability of mimosa, tara and gambier, while quebracho precipitation ability declined with decreasing pH. The results suggest that tannin-protein complexes with quebracho may dissociate in the abomasum, whereas mimosa, tara and gambier may not.

Keywords: *Acacia mearnsii*, *Caesalpinia spinosa*, gambier, mimosa, pH, protein precipitation, quebracho, *Schinopsis lorentzii*, tara, *Uncaria gambir*

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In vitro Gas Production of some Tropical Grasses Using Inocula from Cattle, Sheep and Goats

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This study was conducted to assess the nutritional value of *Panicum maximum, Andropogon gayanus* and *Brachiaria decumbens* as feed ingredients in the diet of cattle, sheep and goats. Although, feed tables are available on chemical composition and utilisation of forages by ruminants, their potentials as feed resources should be continually assessed with a view to ascertain ways of improving their use in livestock feeding systems. Chemical composition of the three grasses was determined. *In vitro* gas production was measured at 3,6,9,12,15,18,21,24,27,30,33,36,39,42,45, and 48 hours of incubation using inocula from cattle, sheep and goat. *In vitro* Organic Matter Digestibility (IVOMD), Metabolisable Energy (ME) and Short Chain Fatty Acid (SCFA) values were estimated.

Effect of interactions between ruminant species and grass species was analysed. Results showed that proximate and fibre contents of *Andropogon* and *Brachiaria* were similar ($p > 0.05$) except their lignin contents. *Panicum* contained highest value of all the chemical components. Protein content of the three grasses ranged from 6.29 to 8.11 %, Ether extract was between 1.55 to 1.94 %. NDF values ranged from 58.08 to 61.09 %. Lignin content was between 8.97 to 9.86 %. Gas production by ruminants; a reflection of rate and extent of digestion, showed that cattle consistently produced highest ($p < 0.05$) volume of gas when fed different forages while gas production from *Panicum* was highest ($p < 0.05$) when consumed by different ruminant species. Significant differences occur in effect of interaction between forage and ruminant species. Cattle fed *Panicum* produced the highest volume of gas through out the incubation periods. The IVOMD of various grass species ranged from 32.29 to 35.79 % while that of animal species ranged from 32.90 to 33.89 %. ME values depend on forages, irrespective of animal species. SCFA of forages ranged from 0.23 to 0.29 μmol/g while cattle fed *Panicum* had highest ($p < 0.05$) value (0.31 μmol/g). The study showed that the *Panicum*, *Brachiaria* and *Andropogon* species have potentials as a fibre source but would require supplementation with higher nitrogen feeds sources to meet the requirements for cattle, sheep and goats.

Keywords: Forage, *in vitro* gas production, ruminant

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Analysing the Quantity of Glucose Released from Perennial Ryegrass Genotypes through Enzymatic Hydrolysis

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Breeding forage crops with high nutritional value trait such as the cell wall digestibility is a vital goal in forage breeding program. Perennial ryegrass is an important forage grass in temperate regions. It is also a primary crop in livestock farming and is becoming a major focus in bio-ethanol production due to its high digestibility. High amount of glucose release describes the rate of digestibility of the cell wall of a forage crop and in return, the high rate of digestibility of the entire forage. Enzymatic hydrolysis is a major way of breaking down complex polysaccharides of pre-treated lignocelluloses biomass into its simple sugar monomer (cellulose to glucose).

The goal of the present study was to estimate the amount of enzymatic glucose released from different genotypes of perennial ryegrass. The genotypes used consist of both wild genotypes (genotypes with unknown rate of cell wall digestibility) and breeding materials (materials that had already been selected based on the rate of their cell wall digestibility). Analysis was done to check for significant differences between these genotypes in the release of glucose. Also, analysis was carried out on different organs (Lamina, leaf sheet and stem) of the same genotype. Data was subjected to analysis of variance (ANOVA) to check for significant differences between genotypes, organs of same genotype and clones of same genotype. Significant differences were detected between the analysed genotypes and between different organs of the same genotype. Variations between genotype in terms of glucose release could be a useful tool in breeding varieties with higher cell-wall digestibility.

Keywords: Cell wall digestibility, glucose, perrenial ryegrass

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Rumen Degradation Characteristics and Tannin Biological Effects of Brazilian Tanniniferous Tropical Plants Based on *in vitro* Gas Production Technique

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Four tanniniferous tropical plants, Aroeira (*Astronian urundeuva*), Catingueira (*Caesalpinea bracteosa*), Jureminha (*Desmanthus virgatus*) and Leucaena (*Leucaena leucocephala*) collected from four sites of Brazilian Northeast during three seasons (August 2008, March 2009 and August 2009) (total 48 sample per plant) were evaluated individually for their ruminal methanogenic potential, degradability and tannin bioactivity based on 24h *in vitro* semi-automatic system for gas production (GP) (2 inoculum per sample plant). Lucerne (*Medicago sativa*) hay was used as control. The plants showed crude protein content of 143, 119, 169 and 212 g kg^{-1} DM for Aroeira, Catingueira, Jureminha and Leucaena, respectively. Methane (CH_4) parameters were calculated based on the truly degraded organic matter (TDOM), tannin bioassay was calculated as % increase in GP in the presence of polyethylene glycol (PEG addition). All data were statistically corrected for season effect (dew point as covariate). The results indicated that the experimental plants decreased ($p < 0.0001$) the GP and CH_4 compared to the control. Aroeira showed the least CH_4 and TDOM either with or without PEG addition and showed the highest values for the % increase in GP and CH_4 production therfore Aroeira presented the highest value for the methane inhibtion potentinal (48.12 %) compared with the control; probably due to its high tannin content (22.6 g condensed tannins per kg DM) whereas both Leucaena and Catingueira reduced ($p < 0.0001$) the CH_4 by 26.2 and 25.2 % without adverse effect on the TDOM as compared to the control. It could be concluded that these plants are potentially promising to reduce the methane production in the rumen and to overcome nutrients limitation in these tropical regions.

Keywords: Degradation and tannin bioassay, gas production, methane, native pasture, polyethylene glycol

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Factors Affecting the Seasonal Pattern of Grazing Distribution in a Mixed Grazing System

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Uneven grazing distribution can cause production inefficiencies and local grassland degradation. Our objective was to analyse seasonal variations in an area explored by cattle and sheep in a mixed grazing system, elucidating which factors control it. Seven Braford cows and Ideal ewes kept in a 130 ha paddock of INTA's Mercedes Experimental Station were fitted with GPS collars during 6 consecutive days in each season for two years (2009–2010). Grassland is constituted by a mosaic of tall and short grasses. Stocking rate was 0.67 AU ha^{-1} (cattle = 0.5; sheep = 0.17). Grazing locations were defined as those which were outside a 20 m radius from water points, mineral supplement and shade trees, and when animals walked with speeds > 0.5 and $< 10\,m\,min^{-1}$. When animals moved less than 3 m in 10 min were considered as resting. Selection ratios (Ivlev´s index) for grazing and resting sites were computed. The area explored (ha) per species per week was estimated through the kernel method. Temperature, relative humidity, precipitation and vegetation availability were also assessed. ANOVA´s results showed that both herbivores differed seasonally in the area explored ($p = 0.02$), cattle exploring larger areas than sheep. Herbivores together reached an almost complete exploration of the paddock in each season (except in winter 2010). Cattle explored larger areas during warmer seasons (r = 0.78; $p = 0.02$), and when tall grasses availability decreased (r = -0.88, $p = 0.01$). Sheep explored larger areas in fall and spring 2009, associated negatively with the relative humidity (r = -0.70; $p = 0.05$), and positively with selection of shade trees as resting sites (r = 0.82; $p < 0.01$). Cattle selected shade trees to rest in summer ($p < 0.01$), which were located at one corner of the paddock. The location of shade trees seems to explain the higher areas explored by both cattle and sheep, but this was not related to the sites selected to graze. Despite the need for shade, herbivores can also reach farther places to graze, implying that location of shade trees didn´t constrained grazing distribution.

Keywords: Cattle, GPS collars, management facilities placement, precision grazing, sheep

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Intake and Digestibility of Elephant Grass Ensiled with Cassava Peels by Red Sokoto Goats

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The nutritive value of elephant grass (*Pennisetum purpureum*) ensiled with varying proportions of cassava peel (0, 10, 30 and 50 %, wet basis) as dry season feed for goats was estimated in a laboratory and digestibility study using Red Sokoto goats. Elephant grass was cut at 12 weeks of age and chopped to approximately 3 cm length and mixed with chopped cassava peel (3 cm length) in the specified proportions. At 21 days of ensiling, the silages were examined for physical properties, pH and proximate composition. Intake and digestibility of silage mixtures were also measured using twelve goats housed in individual pens with slated floors adapted for faecal collection. Results show that pH and physical characteristics of all the silages were within acceptable range. The appearance, smell and texture of the composite silage improved with increasing level of cassava peel in the mixture. The pH of the silage ranged from 3.75 to 4.70 and reduced with higher inclusion of cassava peel in the mixture. Dry matter (DM) intake of the goats increased significantly ($p < 0.05$) as proportion of cassava peel in the silage increased while DM digestibility of the silage also improved. DM intake of goats in this study was 2.55, 2.68, 2.92 and 3.09 % of body weight while DM digestibility was 54.7, 56.7, 64.3 and 68.0 % for 0, 10, 30 and 50 % inclusion levels of cassava peel in the grass silage respectively. These results show that addition of cassava peel to elephant grass improved the physical attributes of the silage and its nutritive value for goats.

Keywords: Cassava peel, digestibility, elephant grass, goats, intake, silage

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Rumen Degradability and Kinetic Properties of Deep Stack Broiler Litter

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Fresh broiler litter was collected from a commercial broiler house that uses wood shavings as bedding material in Khartoum state, Sudan. Chemical composition, rumen degradation and kinetic properties of broiler litter (BL) and three deep stack broiler litters (DSBL) was investigated. Deep stacking was done in underground silo pits $1.5 \times 1.5 \times 1.5$ m (DBSL 1), $1.75 \times 1.75 \times 1.75$ m (DBSL 2) and $2 \times 2 \times 2$ m (DBSL 3) to guarantee a use as ruminant feed. Deep stacking lasted for one month after that representative samples were taken for chemical analysis and rumen degradation trials.

Deep stacking had no significant effect on the chemical composition of BL. Crude protein contents and cell wall components did not change significantly within the three silo pits of deep stacked litter. There were significant ($p < 0.05$) differences in the readily degradable fraction among BL and DSBL, but for other kinetic fractions there were no significant ($p < 0.05$) differences found. Degradability of crude protein increased for the deep stacking treatments ($p < 0.05$) during incubation in the rumen of fistulated buffalos from 35.8 % at 3 h of incubation to 81.6 % after 96 h, from 40.7 to 82.3 %, from 32.5 to 79.3 % and from 35.4 to 81.3 % for BL, DBSL 1, DBSL 2 and DBSL 3, respectively. Degradability of neutral detergent fibre increased ($p < 0.05$) for the deep stacking treatments during incubation from 17 to 71.1 %, 17.3 to 64.8 %, 18.16 to 65.3 % and 16.6 to 63.9 % for BL, DBSL 1, DBSL 2 and DBSL 3, respectively. The rate of degradable fraction for neutral detergent fibre showed no significant difference ($p > 0.05$) among broiler litter and deep stack litters, whereas, the readily degradable fraction, slow degradable fraction, potential degradability and the effective degradability in different rate of outflow showed a significant difference ($p > 0.05$) among all broiler litter and deep stack litter.

The results of this study indicate the possibility of incorporating DSBL into their animal feeding system in order to reduce costs and it will enable the farmers to explore a feasible method of waste management and also to develop their own complementary system of animal production.

Keywords: Broiler litter, composition, deep stacking, degradability

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Impact of Simulated Browsing on Regeneration, Production of Phytomass and Modular Dynamic of *Artemisia herba-alba*

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One of the species candidates to rehabilitate presaharan rangelands is *Artemisia herba-alba* Asso (white Wormwood), unfortunately, overgrazing is by far the most important factor causing the reduction of cover and disappearance of this plant and as consequence the degradation of pre-Saharan rangeland. In this context, this aim of our study is to simulate the effect of browsing at different levels of cutting on the regeneration of *Artemisia*. Hence, plants of *Artemisia herba-alba* collected from Gourrama region (southeast of Morocco) and transplanted in the experimental station of Errachidia, have been submitted to different clipping levels height (C1=8 cm, C2=15 cm, C3= 25 cm) during two periods: autumn (stage of seed filling) and spring (before the starting of flowering). Mean results show highly significant difference between the tree treatments during the two periods. So, as far we increase the volume of plant cut as fast as the performance of production and regrowth are affected, the study has shown that the cutting level C1 produce bad consequences on the of *Artemisia* performances, in fact 60 % of plants cut at this level have died after the second clipping against 25 % for C2 and 2 % for C3. The parameters of growth and modular dynamic are also affected for C1 plants. The phytomass produced after the first cutting is also affected by the level of cutting, differences were highly significant at threshold of 5 %. The effect of increasing the phytomass removed at the first cutting affects plant capability to recompense its losses. Finally, the study demonstrates that clipping at C3 height is the most convenient for white *Artemisia* during the two periods, but we can adopt the cutting at the level C2 for the autumn period.

Keywords: *Artemisia herba-alba*, clipping height, overgrazing, rangeland, regeneration

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Effect of Supplementation with Agro-Industrial by-Products on Mineral Content in Awassi Sheep Milk

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Resource-poor dairy sheep farmers in Middle Eastern countries face high feeding costs in particular during the milk production period. The conventional supplementary feeds used by farmers (control) are based on barley, wheat bran and barley straw and are often unbalanced in energy and protein contents. It has already been demonstrated that locally available feeds like cotton seed cake (CSC), molasses, sugar beet pulp (SBP) and urea-treated wheat straw (UTS) can be utilised to design balanced cost-optimised diets (COD). However, the changed feeding regimes may affect mineral content. This paper examines the effects of CODs on the Awassi sheep milk content of calcium, phosphorus, sodium, potassium and magnesium that play an important role in human bone health.

Five CODs were compared with a control diet at the International Center for Agricultural Research in the Dry Areas, Aleppo, Syria. Forty-eight Awassi ewes were randomly assigned to the six groups. Animals in all COD treatments were kept on grazing as a basal diet, supplemented with the same level of crude protein (229 g d^{-1} and energy (18 MJ d^{-1}). The control group received less protein (190 g d^{-1}) and similar energy levels as the COD groups. Milk samples were collected once every two weeks from April to July.

Diet affected significantly the milk content of minerals. In two out of five CODs, the milk content of calcium was increased by 5-6% compared to the control diet. The CSC and UTS -CODs resulted in a decrease in the content of phosphorus by 3-5%. Also, the content of magnesium decreased by 3-7% in three CODs compared to the control diet. The potassium increased by 7% in one COD, while the content of sodium decreased by 8-12% in three CODs. The mineral content changed by the advance of milking season. The content of calcium and potassium was decreased with the advance of lactation while the content of phosphorus, magnesium and sodium increased with the advance of lactation.

Diets can affect the content of minerals in milk which can make an important contribution to the human daily intake, especially calcium that has a benefit on osteoporosis and on traits of the metabolic syndrome.

Keywords: Agro-industrial by-products, Awassi sheep milk, minerals

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Availability of Animal Feed Resources at Farm and Village Scale in Umurera, Rwanda

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Rwanda is the most densely populated country in Africa, resulting in agricultural intensification and overexploitation of natural resources, the latter leading to food insecurity. To improve the situation the government initiated the 'One farm, one cow'-program, to distribute cows to the poorest families. The viability of the programme was studied, using the research-hypothesis: 'Can each farmer in Umurera produce sufficient fodder to keep cattle?' Umurera-village is representative for Rwanda's Central Plateau area.

Land-availability per farmer ranged between 0.10–2.86 ha. Most important fodder for cattle were: grasses (56 %), banana plant-parts (21 %) and crop-residues (15 %). One quarter (25 %) of the feed consisted of uncultivated grass. The feed composition for cattle of wealth-category II and III is almost equal, while farmers from WC-I fed less grasses and larger quantities of marshland-herbs and crop-residues. The amount of fodder on offer for cattle ranged between 42–179 kg fresh weight per animal per day; some animals were underfed. Fodder-amounts for local cattle of WC-II were substantially lower than amounts on offer for improved cattle, agreeing with literature. Milk-yield ranged between 1.33–4.58 l d^{-1}. The amount of refusals and the chemical analysis of plant samples indicated a low quality of some fodder.

Calculations on current possibilities for farmers to produce fodder resulted in negative conclusions for the poorest farmers (WC-I). The effects of five scenarios were also explored; the quantity of three cultivated fodder-species was increased, decreased or kept equal. The calculated fodder-production (kg DM/year) per farmer indicates that in several scenarios the two poorest farmer groups are likely able to keep local cattle. However, it might be impossible for farmers to realise the necessary investments and the annual fodder-production in Umurera likely differs from the calculated numbers. The programme uses only improved cattle and is therefore not viable in its current setup. The viability would increase if cattle-breed would be changed from *Bos taurus* to *Bos indicus*. Another more realistic option would be the distribution of milking goats.

Keywords: Feed composition, feed quantity, fodder production, one cow-program, Rwanda

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Effect of Fungal Treated Maize Cob on the Performance of West African Dwarf Rams

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Maize cobs (MC) are potential feed resources for ruminants if properly harnessed. Their uses are however limited by high fibre content and low digestibility which can be enhanced by fungal degradation. This study aims at assessing the nutritive value of biodegraded maize cob fed to West African Dwarf (WAD) rams. MC were degraded for 40 days on a large scale with the edible mushroom: *Pleurotus tuber-regium* (PT). Twenty rams were allotted to five groups of four rams per treatment in a completely randomised design. Each group was fed any of the diets in which MC treated PT replaced wheat offal in g per 100 g at 0 (A), 25 (B), 50 (C), 75 (D) 100 (E) as supplement to basal diet of *Panicum maximum*. The experiment lasted for 114 days. Parameters measured were voluntary dry matter intake (VDMI), average daily weight gain (ADWG), feed conversion ratio (FCR), nitrogen balance, ruminal pH (pH), total volatile fatty acids (TVFA's) and ammonia nitrogen (NH_3-N) and apparent digestibility. Significant variation was observed in VDMI. The ADWG recorded for rams ranged (g/d) from 67.73 for rams on control diet A to 70.94 in diet E. Treatment effect recorded for FCR and pH were significant. The TVFA's ($meq\,l^{-1}$) increased from 10.1 in diet A to 12.8 for diet E. The NH_3-N ($mg\,l^{-1}$) increased from 18.2 to 26.40 in diet A and E respectively.

Inclusion of maize cob treated with *Pleurotus tuber-regium* in the diet of rams improved the voluntary feed intake and digestibility. The biodegraded MC can completely replace wheat offal in the diet of West African dwarf rams.

Keywords: Edible-mushroom, fungal degradation, ram, ruminants

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Management of Key Pastoral Resources in Baringo, Kenya and its Impact on the Ecological Conditions of the Resources

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The study addressed the problem of the loss of key pastoral resources / areas essential for the proper ecological functioning of the pastoral systems in Baringo district of central Kenya, which in turn has affected the livelihood of pastoral and agro-pastoral communities leading to hunger and poverty.
The objectives of the study were to study the impacts of the socio-economic characteristics of the local communities on the management of the key resources. Specifically the study aimed at mapping the spatial extent, determining the amount and condition of the key ecological resources and relating this to their management and rehabilitation needs.
The study area was stratified based on the areas occupied by the three main ethnic communities living in Baringo; the Il Chamus, the Tugen and the Pokot. Data was then collected within these three ethnic stratum, using both social and ecological research designs. The sociological techniques included the key informants interviews, focus group discussions, and a sample survey of 379 households. Ecological methods were used to identify, map the spatial extent, and assess the production and the condition of the key ecological resources using remote sensing, geographical information system (GIS), and site assessment techniques.
The data was then analysed using both descriptive and inferential statistics. Indices were developed for this study. An index for biodiversity was used to assess the condition, while an index of conservation based on the coefficient of relative abundance, dominance of the vegetation species, the amount of seed stock in the soil and the general range condition was used to assess the rehabilitation needs of the resources.
The degradation of the key resources was found to be positively associated ($p \leq .05$) to the changes in the three community's socio-economic characteristics (household numbers, livestock mobility, governing institutions, livelihood diversification, land use change, formal educational and technical training). The spatial extent of the degraded land resources was estimated to cover more than 80 % of the 6,869 km^{-1} surveyed. Reseeding, restricting the number of animals, having proper season of use were identified as possible ways the key resources could be rehabilitated.

Keywords: Indigenous management, rangeland management, socio-economic constrains

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Heat Treatment of Tropical Multipurpose Legume Grains Affects *in vitro* Digestion and Fermentation in Pigs

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Tropical multipurpose legumes are interesting protein sources in pig nutrition. However, the digestion of the nutrients of some of them in raw form is often poor. Thus, an *in vitro* study was conducted to test the effect of thermal treatment (raw, boiling and autoclaving for 5 or 20 min [B5, B20, A5 and A20 respectively]) on *Canavalia brasiliensis* (CB), *Lablab purpureus* (LP) and *Vigna unguiculata* (white WVU, pink PVU, red RVU) grains (factorial design 5 legumes $\times$ 5 thermal treatments). An *in vitro* enzymatic digestion of dry matter, protein and starch was determined after pepsin (120 min) and pancreatin (240 min) digestion. Finally, the undigested residue of the *in vitro* digestion was fermented with a faecal inoculum for 72 h and gas and volatile fatty acids (VFA) production measured. Protein digestibility of raw ingredients ranged from 42 (PVU) to 54 % (WVU). In general, this digestibility as well as dry matter, and starch digestibilities increased after the thermal treatment. However, they were significantly influenced by a "legume type $\times$ thermal treatment" interaction ($p < 0.001$). The highest increases on protein digestibility were observed for PVU after A20 (+ 23 %) and B20 (+16 %) and the lowest for WVU after B20 (+2 %) and A20 (+ 6 %). Gas production was also significantly influenced by "legume type $\times$ thermal treatment" interaction ($p < 0.05$). The undigested residue of raw material produced between 362 (CB) to 471 (WVU) ml of gas per g DM incubated. Gas production increased or decreased depending on the legume and thermal treatment (*e.g.* +49, +33, -53 and -12 ml of gas/g DM incubated for LP, PVU, WVU and CB after A20). The concentration of VFA was only influenced by the legume type ($p < 0.05$), with CB presenting the lowest values when compared to the other grains (*e.g.* total VFA 49 vs. 60 mmol l^{-1}). In conclusion, thermal treatment affected differently the *in vitro* foregut digestibilities as well as the hindgut gas production ith each legume. Therefore, the thermal treatment required for improving the foregut digestion or the hindgut fermentation will change depending on the tropical legume used for feeding the pigs.

Keywords: *In vitro* digestibility, *in-vitro* fermentation, pigs, thermal treatment, tropical legume grains

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Implications of Increased Palm Kernel Cake (PKC) Content in Diets of Young Pigs

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Forty-five (45) crossbred (Landrace x Largewhite) growing pigs with a mean body weight of 8.22±0.55 kg were allocated based on body weight, sex and litter origin in a completely randomised design to three dietary treatment groups: (1) 40 % maize + 20 % Palm Kernel Cake (PKC) + 40% basic diet (basal diet), (2) 20 % maize + 40 % PKC + 40% basic diet, and (3) 20 % maize + 40 % PKC + 40% basic diet + feed additive. Each treatment was replicated thrice, with 5 pigs per replicate. The diets were formulated to contain about 18 % and 20 % crude protein for the basal and test diets respectively. These diets were fed to the young pigs throughout the 56-day duration of the study. Record of weekly weight gain, feed intake, feed: gain ratio of the pigs was taken and used to compute other performance parameters. Blood samples were collected from 3 pigs per replicate for the three treatments at the end of the feeding trial for serum metabolites and hematological studies. All the data obtained were subjected to analysis of variance and where statistical significance were observed, the means were compared using the Duncan's Multiple Range (DMR) test. The result showed that the performance traits were neither significantly ($p > 0.05$) influenced by the increased level of PKC nor feed additive, indicating no cost required to be incurred for feed additive. The cost of feed per gain for the higher PKC diets (20%Mz + 40 % PKC diet) were relatively cheaper ($p < 0.05$) compared to the 40%Mz + 20 % PKC control diet. The serum metabolites of the pigs were comparable across the groups but for the serum cholesterol and creatinine levels. The cholesterol values were higher ($p < 0.05$) for the increased PKC diets while the reverse was the case with the creatinine content of the blood serum. All the measured heamatological indices were comparable ($p > 0.05$) across the groups. It could be concluded that this class of pigs can tolerate up to 40 kg PKC per 100 kg diet without any adverse effect on the health status and performance of the pigs.

Keywords: Agro-industrial by-product, feed utilisation, palm kernel cake, pig feed, young pigs

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In vivo Digestibility of *Vigna unguiculata* Grain Meal in Broilers

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Investigating alternative feed for broiler chickens of small producers, the coefficient of apparent digestibility of *Vigna unguiculata* grain in raw and cooked form was determined. Therefore, a completely randomised design with three treatments and six repetitions was applied, substituting weight for weight and using male chickens (line COOB 500) in the finisher phase. They were confined in metabolic cages with 8 days acclimatisation to the ambient and 5 days to the experimental diet previous to the measurement of digestibility. The following treatments were applied: T0 control diet (balanced, non-commercial), T1 70 % control diet control and 30 % raw *V. unguiculata* grain, and T2: 70 % control diet and 30 % cooked (5') *V. unguiculata* grain. The apparent fecal digestibility of raw and cooked grain was determined, as well as of single nutrients of the diet.

The coefficients of apparent dry matter (DM) digestibility of raw and cooked grains of *V. unguiculata* were 66.95 and 72.78 %, respectively. The apparent DM digestibility of the complete diets did not show significant differences between T0 (78.3 %) and T2 (76.6 %), nor between T2 and T1 (74.9 %) ($p > 0.05$).

Single components of the diets did not differ statistically in digestibility ($p > 0.05$): ether extract (87.3 % for T0 and 84,5 % for T1 and T2), crude protein (T0 70,6 %, T2 70 %, and T1 65,2 %). In gross energy (T0 84,2 %, T2 84,9 % and T1 80,5 %), the digestibility of T0 and T2 was similar, and higher than T1 ($p < 0.05$). The three treatments differed significantly in the digestibility of the crude fiber (48,1 %, 31,9 % and 62 % for T0, T1 and T2 respectively). Digestibility of nitrogen-free extract (T0 87,3 %, T1 and T2 84,5 %) was significantly different between T0 and the other two treatments, while ash was similarly digested in T1 (26.8 %) and T2 (34.5 %) compared to T0 (31.9 %) ($p > 0.05$).

The similarity observed for the digestibility and consumption of *V. unguiculata* grain compared to control suggests it as an alternative to soybean meal to reduce production costs.

Keywords: Broiler, grain meal, *in vivo* digestibility, legume grain, *Vigna unguiculata*

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Effect of Microbial 6-phytase on Amino Acid-digestibility of Caecectomised Laying Hens fed Low Lysine-based Diet

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The study assessed the influence of a microbial 6-phytase on amino acid (AA) digestibility, N, P, Ca utilisation and interaction between phytase and lysine of caecectomised laying hens fed lysine deficient diet. The experiment followed a 2×2-factorial arrangement of treatments with two dietary levels of lysine (low: adequate; LLys: ALys) either without at 0 U/kg diet (Phy-) or with at 1000 U/kg diet (Phy+) phytase supplementation. The caecectomised laying hens aged 28weeks were kept in balance crates and 7 individual hens were allocated to each treatment in two periods. Hens were fed the treatment diet for 10 days and excreta quantitatively collected during the last 5 days. The excreta were freeze dried and analysed. The digestibility of amino acids ranged from 0.72 (glutamic acid) to 0.89 (methionine) in ALys Phy- diet and 0.77(lysine) to 0.94(serine) in ALys Phy+ diets; likewise, 0.55(lysine) to 0.90 (proline) in LLys Phy- diet and 0.80 (glutamic acid) to 0.93 (serine and proline) in LLys Phy+ diet. The digestion of lysine AA was numerically reduced by the low inclusion of lysine in LLys + phy- diet and only the digestibility of lysine was significantly ($p < 0.05$) improved of 17 analysed AA. A significant interaction between Lys $\times$ Phy was only detected in lysine AA, but differences in the phytase effects were seen as the digestibility of all AA analysed both in ALys and LLys diets numerically increased. The difference in Mean Digestibility (MD) of AA between Phy+ and Phy- was 0.09 % -units in ALys and 0.08 % -units in LLys. Reduction of lysine in the LLys diets resulted to a depressed dry matter intake (DMI) with numerical improvement in N-utilisation but phytase supplementation was not significant ($p > 0.05$). The difference in MD of DMI was 1.4 % -units in ALys and 3.8 % -units in LLys. Phosphorus intake, P-excreted, P-retention, P-utilised and Ca-intake were only significantly ($p < 0.05$) affected by lysine level while phytase supplementation significantly ($p < 0.05$) affected P-retention and P-utilisation. Numerical reduction in P and Ca-excreted were observed in diets supplemented with phytase. Thus, the inclusion level of lysine in laying hen diet must be met for phytase to be effective.

Keywords: Amino acid digestibility, caecectomised laying hens, lysine deficient diet, microbial phytase

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Sweet Potato (*Ipomea batata*) Meal and its Utilisation by Pullet Chicks: Effect on Performance and Serum Chemistry

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The major problem of poultry industry has been traced to feed cost and availability, solution to this globally lies in increased production of conventional ingredients and utilisation of alternative sources of ingredients. The present study was conducted to investigate the effects of feeding sweet potato meal (SPM) partially or completely replacing wheat bran on the performance digestibility and blood constituents of the pullet chicks. The sweet potato tubers were harvested peeled chipped and dried before milling to have SPM. Three diets were formulated SPM was used to replace wheat bran at 0, 50 100 % levels. Diet I had 18.40 % wheat bran 0 % SPM and served as control while diets II-III had the wheat bran portion replaced at 50 and 100 % level with SPM. Crude protein of compounded ration ranged from 20.76–21.18 % while metabolisable energy varied from 2818.28–3023.16 kcal kg $^{-1}$ assigned to the dietary treatments thirty per group in three replicates and the experiment lasted for ten weeks. Results revealed that average daily feed intake ranged from 41.09–42.65 g day $^{-1}$ those on control were significantly $p < 0.05$ higher than others. The nutrient digestibility feed efficiency of the pullet chicks had the same statistical pattern with feed intake. Blood analysis of the pullet chicks revealed increase in blood glucose while the cholesterol level decreased with increased SPM. Mortality recorded cut across the diets was highest in diet III, report of post mortem revealed laceration of some internal organs. This perhaps explain the blood stained feaces passed by some of these deceased chicks before their death. In the main SPM could replace wheat bran up to 50 % without adversely affecting the performance of the pullet chicks.

Keywords: Performance pullet chicks, sweet potato meal

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Effects of Replacing Maize with Bovine Filtrate Fermented Corn-cob in Layers' Diets

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The scarcity of raw materials is the most threatening problem facing poultry production in Nigeria. Production of cereals such as maize, guinea corn, wheat and protein based grains such as soybean and groundnut have not improved to meet demand. The efficiency of producing most of the feed ingredients is very low. The high cost of conventional feedstuffs has necessitated the search for cheaper alternative feed materials among nutritionists that can meet the nutritional requirements of animals. Such feedstuffs should have the advantage of cost as well as possess very low human food preference to reduce competition between man and animals. Maize has remained the chief source of energy for poultry in Nigeria. Corn-cob is the most prominent cereal crop by-product in Nigeria which is either burnt up or ploughed into the soil. Burning of this material increases the green house gas which further creates negative influence on the ozone layer. In Nigeria abattoirs, bovine rumen contents constitute environmental menace to the environment. However, the rumen is known to be made up of microbes capable of degrading fibrous material which is the limiting component in corn-cob and improve the crude protein level. Laying hens (90) were placed on diets containing bovine filtrate fermented corn-cob (BFC) for 8 weeks (50 weeks in-lay). The BFC was included in the diets at 0, 5, 10, 15, and 20 % of the total diets at the expense of maize. Results showed a significant improvement in CP (10.11 % in BFC and 3.30 % in unfermented corn-cob) and ash while a reduction in CF (28.94 % in BFC - 42.46 % in unfermented corn-cob) and EE of BFC compared to unfermented corn-cob was observed. Feed intake, egg weight and shell thickness were not significantly ($p > 0.05$) affected by dietary treatment while hen-day production and feed per dozen eggs decreased with increase dietary level of BFC ($p < 0.05$). Yolk colouration was improved as the levels of BFC increased in the diets. The result therefore suggests that BFC can serve as feedstuff that is a good alternative to maize in layers' diets up to 20 % replacement.

Keywords: Bovine filtrate fermented corn-cob, laying hen, unfermented corn-cob

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Evaluating Replacement of Maize and Wheat Bran with Sweet Potato Tubers and Vines on Performance, Digestibility and Blood Chemistry of Pullet Chicks

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This study investigated the effects of the mixed feeding of the dehydrated sweet potato tuber meal and sweet potato top meal on the performance, nutrient digestibility and blood chemistry of pullet chicks. One hundred and fifty chicks were used and this study lasted for ten weeks. There were five diets each with three replicates of ten chicks. Diet I served as control with 100 % maize and wheat bran, 0 % sweet potato meal (SPM) and sweet potato tops (SPT) Diets II - III had maize and wheat bran replaced partially with SPM and SPT, while in diets IV-V there was complete replacement.

Results show that the feed intake and body weight gain of the pullet chicks were significantly ($p < 0.05$) affected by the diet. Daily feed intake ranged from 28.02 g for 100 % SPM, 50 % SPT to 42.65 g for chicks on the control diet. Chicks on diet IV (100 % SPM 50 % SPT) had the least value for body weight gain. Feed conversion efficiency shows that those on control diets had the best value. The dry matter digestibilities of pullet on control were higher than others. Among the haematological parameters observed the packed cell volume (PCV),haemoglobin (HB), plasma protein (PP), mean cell volume (MCV) and MCHC were significantly affected($p < 0.05$). The chicks fed control and partially replaced diets had similar haematological values and these were higher compared to other diets. The total protein, albumin, cholesterol, urea, serum alanine transaminase values of all the chicks were within standard range. The glucose value increased as the level of inclusion of SPM and SPT increased. Conclusively partial replacement of maize and wheat bran with SPM and SPT supported growth with no abnormality in blood.

Keywords: Chicks, haematology, performance, nutrient digestibility, serum biochemistry

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Interaction of Natural Food and Supplemental Feeding for Common Carp in Semi-intensively Managed Ponds in the Marginal Uplands of Son La Province, Northern Vietnam

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In the mountainous Yen Chau district, northern Vietnam, each household of Black Thai farmers manages at least one pond contributing tremendously to the food safety and cash income of that household. Traditionally, farmers are culturing a polyculture of grass carp with 2–4 other carp species and Nile tilapia. The production is limited by low quality feed items, the threat to grass carps of an unknown disease, and high turbidity caused by uncontrolled water inflow from highly erosive upland fields. These limitations cause low regional fish production of 1.5 t fish ha^{-1} a^{-1}. To increase fish production, it was suggested to culture common carp as the main species in polyculture using locally available feed resources as supplemental feed. Also, it was investigated whether supplemental feeding for common carp is as efficient under traditional flow-through management as under semi-intensive management with controlled water flow-through.

Net cage trials were performed in two ponds; one managed as a flow-through system with organic fertilisation, another with no water inflow and supplemental inorganic fertilisation. Four iso-nitrogenous feeds based on locally available high-protein ingredients (commercial pig feed, commercial fish feed, fish meal, tofu residue, soybean meal and corn meal) were used as supplemental feed at a rate of 3 % of the common carp's body mass per day. In triplicates, net cages ($2 \times 2 \times 2$ m) were stocked with five common carp fingerlings each. Water quality parameters and abundances of natural feed resources were monitored. Gut content analyses were performed as a measure of consumed natural food. Fish carcasses were analysed chemically to determine the nutritional status of the fish.

Results show, that the first limiting factor for good growth rates in common carp is the amount of available feed energy. Since availability of natural food was low in the flow-through pond growth of the common carp was low. By stopping the water flow and increasing fertilisation, the natural food availability increased and resulted in higher growth rates. All tested feeds showed different effects in growth rates caused by the quality of protein ingredients. An introduction of supplemental feeding practice into this region must go along with an adequate pond management.

Keywords: Common carp, semi-intensive aquaculture, supplemental feeding

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Utilisation of Graded Levels of Ripe and Unripe Banana in the Diet of African Catfish

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Fingerlings of Heteroclarias (*Heterbranchus* x *Clarias*) (7.60±0.00g) were fed ripe and unripe bananas at different dietary levels for a period of 70 days. Nine isonitrogenous (41.0 %) diets were formulated; four dietary levels were tested by substitution with four levels of ripe banana (5, 10, 15 and 20 %) and the other four with unripe banana, while the control was without the test ingredients. A total of 270 fingerlings were distributed in twenty seven plastic tanks (52.5 cm x 33.5 cm x 21 cm), they were hand-fed *ad libitum* twice daily and the water was changed every other day. The weight gain and feed intake by fish were determined at the end of every week and evaluation of the growth parameters showed that the mean weight gain (MWG) and specific growth rate (SGR) of fish fed diets with banana inclusion performed better than the control except at 20 % inclusion of the unripe banana. There was however a decrease in MWG and SGR with increased inclusion of the test ingredients. The feed conversion ratio (FCR), and protein efficiency ratio (PER) recorded significant ($p < 0.05$) reduction in values up to 15 % inclusion of the two test ingredients. The evaluation of haematological parameters showed the haemoglobin (Hb) decreased up to 15 % inclusion, while the white blood cell (WBC) significantly decreased ($p < 0.05$) up to the highest inclusion level except in the unripe group. The cost of feed increased as the level of the test ingredients increased and there was a significant decrease ($p < 0.05$) in the incidence cost and profit index across the test diets with increased inclusion of the test ingredients. However, banana could be used to replace maize during a season of over abundance. The inclusion of ripe banana in the diet of African catfish fingerlings at different levels tested would not have any negative effect on growth and blood parameters, while unripe banana should not be included beyond 15 %.

Keywords: Banana, haematology, *Heterobranchus*, Heteroclarias

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Assessing Specific Dynamic Action in *Cyprinus carpio* Fed Diets of Fishmeal, Magmeal and Rapeseed Meal

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Feed constitutes more than 50 % of operating expenditure in aquaculture. Excess dietary protein not only cost more but also increases energy cost of assimilation by increasing specific dynamic action (SDA). Increase in metabolic rate after feeding has been adjudged an important factor in water quality management in intensive culture systems. In the search for cheaper alternative protein sources in fish diets, preference should be given to ingredients that maximise production of fish while requiring less energy for metabolic activities. This study comparatively evaluated the effect of fishmeal, housefly maggot meal (magmeal), and rapeseed meal diets on the SDA of *Cyprinus carpio*. Three iso-nitrogenous and iso-calorific diets were formulated to yield crude protein of 36.46 $\pm$ 1.28 % (mean $\pm$ SD) and gross energy of 22.01$\pm$0.79 (MJ/Kg) (mean $\pm$ SD) using test feed stuffs. The experiment was conducted using respirometer. Ten round tanks (250l each) composed the respirometer. A total of 17fish weighing 1 kg was stocked per tank. Tank 1 to 9 was stocked, while tank 10 (reference) contained no fish. Each feeding group was stocked in triplicates. Experimental fish were acclimatized 14days. Water temperature was maintained at 14.27$\pm$0.03°C. Rate of oxygen consumption by fish (metabolic rate) was measured for 72 hours using O_2 measuring device which is transmitted and recorded online. On the first day, experimental fish were fed 1 % of body weight at two feeding periods (0.05 % at 8am and 2pm respectively). No food was given on 2nd&3rd day. For each protein source, rates of oxygen consumption (Rmean) were partitioned into components, representing resting rates (Rrest) and apparent specific dynamic action rates (Rsda). Maximal hourly rates (Rpeak) were also determined. Feeding led to increase in oxygen consumption rates which lasted approximately 13–15 hours, in the three diets. Highest peak was obtained similarly in the three diets after 2hours of feeding in the morning and 1hour in the afternoon. No significant difference was recorded in Rmean, Rsda, Rpeak, Rrest, Energy expended on SDA (kJ kg^{-1}) and SDA coefficient (%). The different protein sources did not alter distribution of energy into maintenance needs and apparent specific dynamic action (SDA) effects.

Keywords: *Cyprinus carpio*, magmeal, metabolic rate, respirometer, specific dynamic action

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Growth Performance of Nile Tilapia (*Oreochromis niloticus*) Fed on Different Combinations of Protein Sources

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The Nile tilapia (*Oreochromis niloticus*) is a species of fish in aquaculture quite versatile, being adaptable to both the extensive cultivation without any technology employed and the creation system in cages with full rations and high technology production. The effect of feeding different protein sources on growth performance of Nile tilapia was evaluated in the current study. Isonitrogenous and isocaloric rations (29.73 % CP and 3,000 kcal kg^{-1} digestible energy) using four different protein sources, *i.e.* soybean meal (SBM), coconut meal (CM), fish meal (FM) and viscera meal (VM) were used to the following treatments T1: 100 % SBM, T2: 60 % SBM and 40 % CM, T3: 60 % SBM and 40 % FM, T4: 60 % SBM and 40 % VM; T5: 19 % SBM, 10 % CM, 10 % FM and 11 % VM. Two hundred tilapia fish with an initial weight of 3.4 ± 0.20 g, were distributed in 20 vinyl cages, in a completely randomised design with five treatments and four replicates of ten animals each. Diets were fed *ad libitum* during 88 days. The results indicated that there were significant differences ($p < 0.05$) detected for the final weight, weight gain, feed conversion rate, fillet yield and condition factor for all the experimental diets. However, there was no difference detected between food consumption, weight and content of the fillet profile. It could be concluded that the diets of 60 % SBM and 40 % FM, 60 % SBM and 40 % VM and the combination of four protein sources improved the growth performance compared to the 100 % soybean diet. Also, the efficiency of using mixtures of plant origin may change considerably depending on the type and the quality of meals used in the diets as observed for the 40 % coconut meal and 60 % soybean meal diet.

Keywords: Animal, fish meal, food, plant protein, Tilapia

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Sustainable Utilisation of Cassava Plant for Feeding Monogastric Animals

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Cassava plant meal (CPM) which had 9.0 % crude protein (CP) comprising of unpeeled cassava tubers, leaves and tender-stems was developed to replace maize in the diets of rabbits, pigs, cockerels and broilers. Different growth studies were conducted fwith an eight weeks period with rabbits, eight weeks with pigs, sixteen weeks with cockerels and four weeks with broilers. In broiler study, three experimental diets were formulated. Diet 1 was a maize basal diet of 22 % CP. Diets 2 and 3 had 25 and 50 % of maize in diet 1 replaced with CPM. 153 one week old broiler chicks were randomly distributed into diets. In the study with rabbits, 15 ten-week old new zealand white waener rabbits were randomly alloted to three diets formulated to contain about 15 % CP with CPM replacing 0,50 and 100 % of maize in the diets. In the study with cockerels, 150 day old cockerel chicks were randomly distributed to three experimental diets formulated to contain 16 % CP. CPM replaced 0,50 and 100 % of maize in the diets. 24 growing pigs were used in the pig study and they were randomly distributed into three diets that contained about 18 % CP. CPM was used at 0,50 and 100 % of maize in the diets.The design of the study was completely randomised design.
Results of these studies showed that growth rate decreased and feed to gain ratio deteriorated as the proportion of CPM in the diets of broiler was increased. In the study with pigs, growth rate and feed to gain ratio were not negatively affected by the inclusion of CPM. In the study with cockerels, growth rate and feed to gain ratio were negatively affected with the inclusion of CPM in the diets. The inclusion of CPM to replace maize in the diets of growing rabbits resulted in improved performance of the animals in terms of daily gains, feed intake and feed to gain ratio.
Findings from these sudies suggest the suitability of CPM to replace maize completely in the diets of pigs and rabbits. Partial replaceent of maize with CPM gave satisfactory performance with cockerels and broilers.

Keywords: Broilers, cassava plant meal, cockerels, feed to grain ratio, growth rate, maize, pigs, rabbits, week diet

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Apparent Ileal Digestibility of Crude Protein and Amino Acids in Wheat Offal Diets for Broilers

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Apparent ileal crude protein and amino acid digestibility of wheat offal (WO) at varying levels of inclusion (0, 10, 20, and 30 %) was determined for broiler chicks in a 7 - day experiment. The feed ingredient (WO) used served as the sole source of amino acids, as other feed ingredient were fixed. The birds received a commercial broiler starter diets during the first 14 day posthatch. On day 14, birds were sorted by body weight and randomly distributed into 4 dietary treatments in a completely randomised design. Each diet comprised of 4 replicates of 5 birds per each from day 14 to 21 posthatch. On day 21 posthatch, birds were asphyxiated with CO_2 and digesta samples from the terminal ileum were collected. Titanium dioxide was included as the indigestible dietary marker. The concentration of crude protein increased as the level of WO increased across the diets. In general, the concentration of essential amino acids in wheat offal - based diets, was highest in diet containing 10 % wheat offal and lowest in diet containing 30 % WO. The digestibility of all the essential amino acids significantly ($p < 0.05$) decreased as the levels of WO increased across the dietary treatments except for the control diet. Apparent ileal digestibility of crude protein and amino acids in birds on wheat offal diets were improved across the diets. The digestibility of essential amino acids improved significantly ($p < 0.05$) at 10 % WO inclusion level as compared with other test diets. Threonine digestibility was lowest when compared with digestibility of other essential amino acids across the diets. In conclusion, the data from the present study showed that there were considerable differences in varying levels of WO in the digestibility of their amino acids for broiler starters. Therefore, it is imperative to consider lower levels of WO inclusion, as a level above 10 % resulted in decreased digestibility of crude protein and amino acids.

Keywords: Amino acids, broilers, crude protein, ileal digestibility, wheat offal

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Product quality and processing

Assesment and Perspectives of Mechanical-power Technology Implementation in Agriculture in Angola

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One of the important factors influencing agricultural production is the utilisation of technology. Technology applied in agriculture can be classified according to the origin of power into three levels: human, animal and mechanical. Angola still carries the burden of consequences after the long-lasting civil war terminated in 2002. Almost 70 % of the Angolan population is considered as agricultural, thus directly dependent on agricultural and related activities. The majority of them use hand-tool technology for agricultural production which is often not sufficient to sustain food security of the peasants' families. In 2010 the country was still significantly dependent on imported food. On the other hand, Angola has proved high economical growth rate since 2004. Even though, the Angolan economic growth is mainly driven by the oil sector, there are good financial conditions for increasing the implementation of mechanical-power equipment in agricultural sector and so insuring food security in the country. The survey aimed at the assessment of the current situation of the utilisation of mechanical-power equipment in agriculture and its future prospects with special regard to the possibilities of its utilisation within farmers' association. The survey was conducted in both governmental as well as private sectors at national and provincial level from May 2009 to October 2010. Methods of data collection included semi-structured personal interviews and questionnaires. The results show that nowadays the mechanical-power equipments are used only on 1 % of total cultivated land in Angola. The annual rate of total land cultivated by mechanical-power equipment increased by 7 % in agricultural seasons 2007/2008 – 2008/2009. The work capacity of a tractor in the last documented agricultural season 2008/2009 was 77.6 hectares, number of tractors per 1000 hectares reached only 0.61. The number of mechanical-power equipment is steadily changing due to the average service life of about two years. Unsuitable models of tractors and their implements, low level of maintenance and lack of spare parts, lack of qualified human resources and training capacities are the principle obstacles impeding broader utilisation of mechanical-power equipment.

Keywords: Agricultural development, Angola, mechanical-power technology, tractor

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Improving Air Distribution and Drying Uniformity in a Batch Dryer for Agricultural Products

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Batch dryers are the most common practice of drying on farm level in tropical countries, *e.g.* for paddy, cocoa and other agricultural products. Uneven air distribution is a main problem in their performance. Zones receiving a higher airflow rate dry faster, and this heterogeneity reduces efficiency by increasing energy consumption and drying times. A box dryer was built and tested and computational fluid dynamics was used to simulate its air distribution. The dryer consisted of a plenum chamber above which plastic boxes holding the product are placed. A middle wall separated the plenum in two equal halves, so that the whole dryer or only one half can be used. A fan was connected to both halves through a Y-shaped duct of the same cross-section as the fan outlet.

Simulations showed that this configuration produced a deficient air distribution to the different boxes. Trying to overcome this problem, simulations were conducted with a modified design consisting of a wide inlet into the plenum chamber. The results showed an almost perfectly uniform air distribution. This was therefore considered satisfactory for further study, which consisted of finding a suitable diffuser to serve as transition between the small cross-section of the air ducts and the wide entrance to the plenum. It was seen, both from theory and from flow simulations, that simple diffusers need to be prohibitibely long to serve their purpose. However, short, wide-angle diffusers can be equipped with air guides and perforated plates to remain effective. Simulations were done of different diffuser designs, trying to find one which fulfils its function with a minimum of length.

Drying trials with woodchips were conducted for the original and modified dryer configurations, during which the drying course and airflow of each box were measured. Results for the original configuration showed, like the simulations, a wide variation in airflow among boxes, and also the expected wide differences in drying rate. A very significant correlation between these two variables was found in all cases. The modified version resulted in much more homogenous air distribution and drying rates and therefore represents a viable option to improve dryer efficiency.

Keywords: Air distribution, batch dryer, computational fluid dynamics, dryer performance

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Evaluation of Heat-sensitive Micronutrients in Fresh, Sun-dried and Solar-dried *Capsicum* Varieties Grown in Peru

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The genus *Capsicum*, with its centre of origin in Central and South America, is an important ingredient in national cuisines. Most species are found to contain high contents of carotenoids such as ß-carotene which can be metabolised in human body to vitamin A. Vitamin A deficiency is a global problem affecting millions of people, especially children and pregnant women. Additionally, *Capsicum* is also rich in vitamin C and capsaicin which gives a pungent taste. Particularly in Peru, many small-scale farmers live from the cultivation of local capsicum varieties, which is sold both as fresh and dried material. This work aimed to evaluate the content of carotenoids and vitamin C of some local species of *Capsicum* as well as the effect of drying via different methods under Peruvian winter conditions at the coast. The traditional procedure of open sun drying directly on the ground, suspected to cause considerable nutritional losses and decrease product quality, was evaluated against the use of advanced solar drying technology, namely the 'Hohenheim' tunnel dryer. Comparisons were made between fresh and dried materials using three local commercial varieties of different *Capsicum* species. Additionally, six local accessions of a gene bank were analysed. Analyses were carried out by conducting high performance liquid chromatography (HPLC) using methods adapted especially for this study. Furthermore, measurements of water activity, moisture content and surface colour before, during and after drying were obtained. In this study, the vitamin and carotenoid content of three local varieties and six accessions of a gene bank in Peru were identified. It was observed that drying in the traditional way was almost impossible under Peruvian winter conditions (coast) and resulted in microbiological degradation, whereas almost all solar dryer samples reached the aimed moisture content. Dried *Capsicum* with higher carotenoid and vitamin content provides products of better nutritional and economic value, which will contribute to food security.

Keywords: *Capsicum*, carotenoids, high performance liquid chromatography, micronutrients, Peru, solar drying, vitamin C

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Safety of Horticultural and Livestock Products Originating from Urban and peri-Urban Enterprises in two West African Cities

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In many African countries, urban and peri-urban agriculture is very important for income generation of farmers and customer supply with fresh vegetables and fruits, meat, eggs and milk. However, it raises numerous public and environmental health concerns, due to intense use of fertilisers and pesticides in vegetable production and unhygienic conditions especially in the dairy sector. Therefore the present study assessed the contamination of irrigated lettuce and cow milk with fecal pathogens, and of tomato and cabbage with pesticide residues in the cities Bobo-Dioulasso (Burkina Faso) and Sikasso (Mali). During, cold dry, hot dry and rainy seasons, samples were taken from irrigation water, organic fertilisers and lettuce in seven gardens across the two cities, and of curdled and raw milk in six dairy farms in Sikasso. Pesticide residues were analysed in samples of cabbage and tomato from eleven and three gardens, respectively. Data on registered incidences of diarrhea/vomiting and typhoid fever were gathered from eleven health centres at Sikasso. Wastewater and organic fertiliser were major sources of lettuce contamination with thermo-tolerant coliforms and *Escherichia coli* – their concentration in irrigation water by far exceeded WHO recommendations for unrestricted irrigation of vegetables consumed raw. Contamination levels of lettuce at farm gate and market place were higher in Bobo-Dioulasso than in Sikasso ($p < 0.05$), and dry season contamination levels were higher than rainy season levels in both cities. Concentrations of thermo-tolerant coliforms and *Escherichia coli* were higher in curdled than in raw milk ($p < 0.05$) at all sampling dates. Residues of the pesticide Cypermetrin were detected in only one cabbage and one tomato sample; in both cases the concentration was below the maximum threshold limit for consumption. From 2005 to 2009, the registered cases of diarrhea/vomiting and typhoid fever had increased by 65 % and 400 %, respectively, in Sikasso; they might be linked to consumption of contaminated vegetables and milk. A holistic approach that improves hygienic standards along the production, processing and marketing chain is needed to reduce consumer health risks ensuing from current production and post harvest processing practices of highly perishable commodities in West African cities.

Keywords: Bobo-Dioulasso, *Escherichia coli*, milk, pesticide residues, Sikasso, thermo-tolerant coliforms, vegetables

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Assessing the Appropriability of Food Processing Technologies Based on Renewable Energies Applying a Need-oriented Methodology

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Food is a basic human need, as is the production and preparation of it. All forms of food preparation are linked to the provision of energy. In rural areas biomass is the dominant energy source. About 2.5 billion people worldwide rely on wood, agricultural residues or dung as source of energy for cooking, but often used in a traditional, inefficient and unhealthy way. If no changes are made, this figure could even increase to 2.7 billion by 2020. Wood as energy source is becoming increasingly scarce, especially in marginal lands, and the rising demand is leading to deforestation, desertification and longer collection times.

The need-oriented methodology presented in this paper is based on research results from WISIONS initiative, run by the Wuppertal Institute. The initiative intents to improve the South-South and North-South knowledge transfer on sustainable energy models and technologies. The initiative's scientifically founded information tool, called "Technology Radar", aims to give a comprehensive overview of technologies and their possible contribution to meeting basic energy needs. The energy-related need "Food processing" is the second topic to be regarded, it addresses processes such as cooking, baking, drying, refrigerating, pressing and milling, based on renewable energy resources. To evaluate the applicability and appropriateness of these technologies, a set of criteria was defined: potential contribution to global sustainable development and to achieve the Millennium Development Goals; environmental impacts; socio-economic aspects and regional impacts; economical viability and expected technological developments.

In the last six years, WISIONS also selected and supported more than 50 small-scale implementation projects in various developing countries. One third of these projects dealt with sustainable energy supply for food processing. In the analysis it became apparent that the socio-economic and institutional context represents the most significant constraint for the implementation. The underlying aim is to ensure the long-run adoption of the technologies, *i.e.* as part of the daily routine of people. This implies a process of adaptation at the user level as well as changes of the socio-economic structure.

The findings of the technology radar as well as lessons learned from the practical implementation are presented in this paper.

Keywords: Community-based solutions, developing countries, food, food processing technologies, information tool, renewable energy, sustainability

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Between Isomorphism and Entrepreneurship: The Impact of Standardisation on Product Quality, Market Access and Livelihoods in Kenyan Banana Production

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The access of smallholders to markets is increasingly seen as a solution to the problems of food security and poverty in sub-Saharan Africa (SSA). To date, research attention has predominantly focused on the barriers for smallholders to further integrate with their markets, such as high transaction costs caused by among others weak infrastructure and tariff as well as non-tariff barriers. Standards for product quality have to that respect become a factor of growing importance for smallholders not only to access export markets but increasingly also for domestic markets like supermarkets. A growing number of scholars, however, recognise that these standards are not only barriers but also opportunities for smallholders in that they clarify the requirements to access markets. Hence, a research gap pertains to how smallholders perceive and recognize the opportunities in their market environment and how they act upon these opportunities. To help to fill this gap, this study develops a theoretical framework that draws on strategic marketing literature and case study research on banana farmers in the Kenyan highlands and Kagera region in Tanzania. The final conceptual framework distinguishes between two basic entrepreneurial approaches of smallholders,*i.e.* the continuous exploration of new crop-market combinations and the exploitation of a single crop-market combination that is optimized to respond to a single market opportunity. The development of a particular approach by a smallholder depends on and its effectiveness is constrained by the institutional environment. This puts smallholders in varying positions between two extremes of isomorphism (similarity) and entrepreneurship (innovation).

Keywords: Banana marketing, entrepreneurship, isomorphism, markets access, product quality, small holder, standardisation

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Warburgia ugandensis – Bioassay of Different Plant Parts Concerning the Antimicrobial Activity

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The bark of *Warburgia ugandensis* is widely used as an herbal medicine in Kenya and other parts of Africa. It is used against stomach-ache, malaria and is active against different bacterial and fungal infections. However, the intensive use of the bark is severely damaging the trees. In our experiments we used different plant parts to find a less harmful and sustainable way of using the tree.

In 2010 we conducted some bioassay studies in the laboratory of JKUAT (Kenya) to test the inhibition activity of bark, fruit, leaves and root against some potentially stomach upset causing microorganisms (MO), namely *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli* and a fungus *Candida albicans*.

We prepared crude extracts of different concentrations (1, 2, 3, 4, 5 g/100 ml) from grounded powder of bark, roots and leaves, as well as fresh fruit. 5mm diameter filter paper discs were impregnated with about 2μl of the extract and placed on the agar plates inoculated with the test MO (100μl). For each test MO, three replicates were prepared for each treatment combination. The plates were incubated at 37°C for 23hrs, after which the diameters of inhibition zones around the paper discs were measured.

The average inhibition zones for leaves (11.21 mm), fruits (12.48 mm) and roots (13.2 mm) were all significantly ($p < 0.01$) larger than the one from bark (10.29 mm). The inhibition zone was not always increasing with increasing concentration, bark and leaves showed a peak for 2 g/100 ml (11.27 mm, 12.53 mm). Fruits showed two peaks, one at 2 g/100 ml (13.27 mm) and the other at 4 g/100 ml (13.43 mm). The best result was shown by roots at 4 g/100 ml (14.80 mm).

The high potency of roots is a good alternative although less sustainable than leaves and fruits. From our findings we can conclude that crude extract of leaves at 2 g /100 ml concentration, but also the fruit is good for sustainable utilisation of this medicinal tree at least for infections caused by the tested MO. However, there is further research needed, since our sample size was relatively low and we used the bark of big branches. Healers would use the bark of stem which might give better results.

Keywords: Bark, bioassay, crude extracts, herbal medicine, microorganisms, sustainable harvest, traditional medicine, *Warburgia ugandensis*

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Association Mapping of High (1–3, 1–4)-β-d-glucan Content in Spring Barley Grain (*Hordeum vulgare* L.)

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High β-glucan content barley (*Hordeum vulgare* L.) is an important parameter for evaluating food, feed and malt quality. Association mapping based on linkage disequilibrium (LD) is a method to determine whether candidate genes are associated with variation in a trait of interest using natural population and to localise polymorphisms that contribute to this variation. This study focused on chromosome 1H because of previous evidence of Quantitative Trait Loci(QTL) for barley high ß-glucan content on this chromosome. Blank et al. (2006) have been identified three QTL for barley high ß-glucan content on chromosome 1H linked to SSR markers HVALAAT, Bmag0211 and Bmac0090. Based on these QTL, the goal of the present study was to (i) validate the application of association mapping in detection of the QTL that control barley β-glucan content on the chromosome 1H and (ii) estimate haplotypes among the spring barley accessions and use haplotypes in computing linkage disequilibrium. Altogether 153 spring barley accessions have been genotyped by means of simple sequence repeat (SSR) DNA-marker and, in parallel, phenotyped for barley β-glucan content for two seasons. Statistical analyses were carried out with the SAS version 9.1 (SAS Institute 2005) and the programme Tassel (http://www.maizegenetics.net). The resulting analysis of diverse haplotpyes revealed decay of LD between all pairwise loci ranging from 0.00 to 0.08 with an average of 0.03. Only one SSR marker was significantly associated with high β-glucan content in 153 spring barley accessions. The results in this study, demonstrated that association mapping is a valuable additional tool in the search for major genes and QTLs especially for complex traits, like high β-glucan, for which measurements are costly and time-consuming.

Keywords: Chromosome 1H, haplotypes, linkage disequilibrium, quantitative trait loci, QTL, simple sequence repeat, SSR

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Finding the Genes and Proving Causality: New Forward and Reverse Genetic Tools and their Application in Rice

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The goal of plant breeding is to combine naturally occurring genetic variation between species, strains and varieties to create superior varieties. Being able to locate the genomic region responsible for the trait of interest accelerates this process, because it allows for more direct selection of the breeding material.

Traditionally, standard genetic mapping a trait of interest in crops required established sets of molecular markers able to distinguish the parental lines to genotype the progeny. Marker development and genotyping individual plants is tedious and costly. We developed a method for genetic mapping by 2nd-generation sequencing, which does not require prior knowledge of molecular markers and will also directly yield the causal polymorphism. It is based on bulked segregant analysis of pools of plants. By sequencing two samples, one lane each on the Illumina Genome Analyzer II, we mapped the causal nucleotide change for a recessive virus resistance in a segregating population of two non-reference indica rice strains within a few weeks. While a reference genome is necessary, sequence information of the parental genomes is not.

The current resolution of genetic mapping projects often only allows one to define a region of the genome responsible for the trait rather than attributing it to a single gene. However, researchers are often able to identify one or several candidate genes in those regions. Specifically silencing these genes *in vivo* and monitor the effect is an effective way of testing the candidates. This can be achieved by post-transcriptional gene silencing (PTGS). Silencing genes with Artificial miRNAs (amiRNAs) – designed to target one or several genes of interest – have been shown to be a highly specific approach in plants.

We devised an amiRNA-based strategy for both japonica and indica type strains of cultivated rice, *Oryza sativa*. The adoption of this technology to rice will be described. Besides candidate gene validation, the technology may be used for comparative functional genomics between different varieties, and for improvement of agronomic performance and nutritional value.

Keywords: Candidate gene validation, gene silencing, genetic mapping, rice

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Aging Milled Rice by Radio Frequency Heat Treatment

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This investigation aimed at evaluating the radio frequency (RF) heat treatments as an alternative aging technique for 6 months milled rice storage. The experiment was conducted at the Postharvest Research Institute, Chiang Mai University, Thailand. Milled rice cultivar KDML 105 with an initial 11.6 percent moisture content was used. The samples were exposed to RF heat treatments at the operating frequency of 27.12 MHz with treatment temperatures of 70 and 85°C. The treatment durations were 5, 10 and 15 minutes. Their cooking qualities were evaluated using the elongation ratio of kernel, the gel consistency, the texture, and the viscosity. The RF heat treatment at 85°C for 5 minutes provided the give the best results; the moisture content decreased to 11.2 percent which was the lowest moisture loss as compared to the control, the ratio of kernel elongation increased from 1.345 to 1.367 and the gel consistency significantly decreased from 9.87 to 9.70 cm, whereas their textures as hardness and stickiness significantly increased 17.62 %, 21.25 %, respectively. In addition, the viscosity profiles which are the values of breakdown (from 538 to 599 RVU), the final viscosity (from 4197 to 4233.33 RVU), and the pasting temperature (from 71.23 to 78.63°C) increased, while the value of setback (from 1604.3 to 1425.8 RVU) decreased. It was concluded that the physical properties of milled rice after RF treatment at 85°C for 5 minutes were equivalent to those from 6 month storage. Therefore, it can be suggested as alternative rice aging technique.

Keywords: Aging, cooking qualities, milled rice, radio frequency

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Effect of Ageing on Chemical Composition and Quality of Desert Camel Meat (*Camelus dromedarius*)

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The present work investigates the effect of ageing on chemical composition and quality of the one humped desert camel meat (*Camelus dromedarius*). A total of 7 she-camels (3–4 y-old) fattened by the local camel herders and slaughtered following the normal abattoir procedures in the Sudan. Longissimus thoracis (LT) muscle were obtained from the left carcass sides of all camels, divided into 4 portions, stored at 1–3°C and aged for 1, 3, 5, and 7 days. Chemical composition, pH, drip loss (DL), water holding capacity (WHC), meat colour, fat peroxidation (MDA), vitamin E and myosin heavy chain (MyHC) isoforms were investigated. Ageing of camel longissimus dorsi muscle influenced significantly ($p < 0.001$) moisture, crude protein, and intramuscular fat. The separation of different MyHC isoforms by electrophoresis SDS-PAGE revealed two MyHC isoforms (MyHC I and MyHC IIa) in camel LT muscle with mean percentages of 64.1 % and 35.9 %, respectively. Significant differences were found during ageing in pH, MyHC types I and IIa, colour, and WHC, however, significant differences were found in drip loss. The formation of MDA increased after 3 days of ageing from 0.08 μg/ g in day 1 to 0.24 μg/ g in day 7 with no significant differences. Camels LT muscle was found to be rich in vitamin E (17.8 μg/ g) compared to previous studies in bovine. Ageing did not affect vitamin E significantly and possibly could be suggested as an effective antioxidant against fat peroxidation in camel meat.

Keywords: Desert camel, longissimus thoracis, meat quality

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Variation of Phytanic Acid in Transition from Conventional to Organic Milk Production

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Nowadays, many consumers switch from conventional to organic milk, and the demand in organic milk and dairies is high, despite the higher price. Thus, falsely labeled organic products may be found on the market. Therefore, consumers raise the question "Can we trust organic milk?" The availability of reliable analytical methods is fundamental for the authentication of organic milk and dairies. The main difference between organic and conventional milk is the feed supplied to dairy cows. Thus, most approaches are based on identification of markers' characteristic for feed items. One suitable method is gas chromatography coupled with mass spectrometry based on determination of milk fatty acid. The difference in milk fatty acid pattern is due to different feed intake of cows as grass based or pasture versus concentrate.
Our previous studies have indicated that phytanic acid might be a valuable marker to distinguish difference between organic and conventional milk. Phytanic acid cannot be *de novo* synthesized by mammals. It is completely derived from the cows' diet because its initial source is chlorophyll. Therefore, phytanic acid is supposed to be higher concentrated in organic (mainly grass-based diet and pasture) than conventional milk (higher proportions of concentrate). Furthermore, a target value of 200 mg phytanic acid per 100 g milk fat was proposed for the authentication of organic milk. In this study we analysed milk samples from a farm in transition to organic farming. The mean concentration of phytanic acid of 287 mg per 100 g milk fat was above the suggested target value of previous studies. Hence, phytanic acid can be recommended for authentication of organic milk and it may serve as a reliable marker for the differentiation of organic and conventional milk. Research is ongoing to further verify this claim.

Keywords: Farm in transition, gas chromatography/mass spectrometry, organic milk, phytanic acid

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Use of Different Pretreatments During Drying of Eland (*Taurotragus oryx*) Meat and its Effect on Organoleptic Properties

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World demand and consumption of animal products in human diets is growing worldwide. One of the promising species for the production of venison is eland (*Taurotragus oryx*). Domestication of eland for agricultural production in Africa was also recommended by FAO. Eland is the largest species of antelope comparable with domestic cattle, not only in size but also in terms of its peaceful nature. From the perspective of developing countries, drying appears to be low cost preservation technique in the processing of agricultural products. It is possible to obtain a product with the optimum value of moisture, which in turn provides the possibility of storage and minimising the risk of contamination by fungi, microbes, etc.

The main objective was to investigate the influence of different drying pretreatments on organoleptic properties of eland meat. In the first part of the experiment, eland meat from biceps femoris was cutted into samples and loaded into different modified marinades. Samples were dried in laboratory oven 20 hours at 50ºC and weighed each hour. Ten pretreatments with the best organoleptic effect were selected by visual observation to be dryed in solar dryer. AANaCl (vinegar 4 % - 10 min., 10 % saline solution - 10 min.), AB1 (lime juice 30 ml with water 70 ml for 10 min.), AB2 (lime juice 50 ml with water 50 ml for 10 min.), AC1 (pineapple juice 50 % for 10 min.), AC2 (pineapple juice 100 % for 10 min.), M (honey solution 60ºC for 10 min.), MAB (honey solution with lime 60ºC for 10 min.), NaClV1 (10 % saline solution for 10 min. and red wine for 10 min.), NaClV2 (10 % saline solution for 10 min. and red wine 60ºC for 10 min.), CC (control sample). Average initial and final moisture content was 75.6 % and 14.25 %, respectively. Sample NaClV1 showed the biggest moisture loss of 67.33 %, sample M showed minimal moisture loss of 50.93 %. After drying the samples will be tested by trained panelists to evaluate the influence of each pretreatment on organoleptic properties.

Keywords: Drying, eland, meat

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The Influence of Pre-treatments on Drying Kinetics of Chilli Pepper

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The aim of this work is to investigate the influence of pre-treatment on drying kinetics of chilli pepper at various air temperatures. Dehydration of agricultural product is energy intensive process in which energy expense constitute a major portion of drying cost. At temperatures of 35, 50, 60, 70, 90°C for pre-treated and untreated red chillis, the total drying time were determined experimentally. It was observed that as the temperature of drying air increases, drying time decreases for pre-treated as well as un-tread chillis but much shorter drying time could be achieved with application of pr-treatments. Because of availability of water and its low cost, blanching with hot water was found to be the best pre-treatment method relatively with shorter drying time. Based on the standard value of the final moisture content of dried material, *i.e.*, 13.6 %(db), an optimum drying temperature was between 50°C and 60°C.

Keywords: Chilli pepper, drying kinetics, drying time, energy, moisture content, pre-treatment

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Minimal Processing Application to Extend Shelf-life and Preserve Quality of Fresh-cut Pineapples

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Pineapple (*Ananas comosus*) is an exotic tropical fruit which is popular due to its sweet-sour taste and high nutrition content, especially vitamin C. Most of people prefer to consume fresh pineapples, although pineapple-based products are available diversely. The consumption of fresh-cut fruits usually faces some limitations because they are perishable substances, susceptible for discolouration, texture softening as well as nutrition losses. Therefore, additional treatments are required for extending shelf-life of fresh-cut fruits. Minimal processing is a technique in food production to provide sufficient shelf-life and preserve the fresh-like quality as well. The simple and inexpensive process is considered as an appropriate method to provide fresh-cut pineapples by small-scale industry. The objective of this research was to investigate the effects of immersion in calcium chloride and ascorbic acid solutions on the chemical and sensory properties of fresh-cut pineapples during storage.

Ripe-stage pineapples were harvested from the farmers' fields in Pemalang, a centre of pineapples production in Central Java, Indonesia. The fruits were peeled, trimmed and cut into 8 slices of edible parts. Fresh-cut pineapples were immersed in the 0.2, 0.3 and 0.4 % of calcium chloride solutions and in the 200, 300, and 400 ppm of ascorbic acids solutions, respectively. They were then stored in the refrigerator (12–15°C) and investigated every 4 days during storage. Fresh-cut pineapples without treatments were also performed as a control. Sensory analysis of 4-point scale with 15 assessors was conducted to evaluate colour, texture, flavour and overall impression. The chemical properties determined were moisture, total sugars, and vitamin C content.

The results showed that all samples from the treatments were still acceptable after being stored for 8-days which was longer than for the control. Storage for 12-days was not recommended due to significant changing in the sensory properties. Discolouration and texture degradation contributed significantly to the assessors' impression. Immersion in ascorbic acid solution maintained vitamin C content during storage. Moreover, there were no significant effects on moisture and total sugars content during 8-days storage.

Therefore, this additional procedure can be recommended to small-scale industry on providing fresh-cut pineapples.

Keywords: Fresh-cut pineapple, minimal processing

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Application of Nonthermal Technologies for the processing of Camu Camu (*Myrciaria dubia*)

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Myrciaria dubia HBK Mc Vaugh, camu camu is an endemic plant of the Peruvian Amazonas. The fruit is one with the highest vitamin C concentrations in the world as well as with significant amounts of phenolic compounds and a high antioxidant capacity. Nevertheless, products with a high vitamin C content degrade relatively quickly after conventional extraction or pasteurisation methods, which employ high temperatures. These methods cause changes in physical, chemical and biological characteristics, and therefore degradation of the nutritional value. Thus, it was necessary to consider alternative methods, which do not apply such high processing temperatures. Nonthermal treatments such as PEF (pulsed electric fields), US (ultrasound process) and HHP (high hydrostatic pressure) were evaluated in this work as alternatives to conventional extraction and pasteurisation treatments of camu camu. Taking into account the above mentioned studies, it can be concluded that the waste ocurred after camu camu pulping (seed, peel) posseses outstanding nutritional properties, such as high vitamin C contents, a high content of phenols, as well as antioxidant properties. Furthermore, it has been shown that by the application of non-thermal technologies, the valuable properties, and those in conservation storage of the camu camu pulp, have been significantly improved. The possibility of the storage as well as transportation of camu camu products at 4° C represents an economic alternative for the producers, as well as for current and prospective exporters. With these results, it is expected that the interest of local and international fruit producers in the qualities of this fruit is aroused, leading to a further development of the Amazonian agriculture.

Keywords: Camu camu, HHP, *Myrciaria dubia*, nonthermal treatments, PEF, vitamin C

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Total Phenolic Content and Antioxidant Potential of Traditionally Processed *Mucuna monosperma* Seeds: An Indian Under-utilised Legume Grain

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Accumulation of chemical, biochemical, clinical and epidemiological evidences indicate an inverse correlation between the consumption of legume seeds and incidence of several chronic diseases. Such obvious health benefits of legume seeds are believed to contribute by the presence of polyphenolic compounds. Therefore, recent studies are mainly focusing on the health promoting/disease preventing role of phenolic compounds in legume grains. In this context, the seed materials of *Mucuna monosperma* DC ex Wight (common name: Negro bean, local name: periyattalargai), an Indian underutilised food legume received more attention. The boiled Negro bean seeds are eaten by tribes of Northeastern India, the Oceanic group of tribes, the Onges, Great Andamanese and Sompens. In the present study, the methanolic extract of Negro bean was analysed for total phenolic content and antioxidant properties. The raw seeds contained a total free phenolic content of 13.82 $\pm$ 1.69 g catechin equivalent/100 g extract DM. Ferric reducing/antioxidant power (FRAP, 1446 mmol Fe[II]/mg extract), inhibition of ß-carotene degradation (48.81 %) and scavenging activity against DPPH (64.40 %) and superoxide (43.78 %) radicals were exhibited by the extract. A significant correlation was recognised between the phenolic content and antioxidant properties. When considering the effect of traditional processing methods, sprouting + oil-frying caused an apparent increase on the total phenolic content and a significant improvement in the antioxidant and free radical scavenging capacity of Negro bean, while soaking + cooking as well as open-pan roasting treatments showed diminishing effects. Thus, sprouting + oil-frying treatment could offer a good strategy to improve the phenolic content and antioxidant activity in Negro bean. Therefore, such suitably processed under-utilised legume grain with substantial antioxidant activity could be envisaged as a dietary ingredient in the formulation of supplementary foods with therapeutic values.

Keywords: Antioxidant activity, *Mucuna monosperma*, Negro bean, total phenolics, traditional processing methods

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Effects of Corm Density and First Irrigation Date on Saffron Yield

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Saffron (*Crocus sativus* L.), one of the most expensive medicinal plants of the world, is an autumn-flowering plant extensively grown on marginal lands in Iran. Because of it resistance to extreme temperatures (varying from 40°C during summer to -18°C in winter) and its resistance to drought, saffron is a good choice for cultivation on marginal drylands as in the West of Iran. Based on historical documents the production of saffron is practised in western Iran since a long period of time but there was a marked reduction in saffron production during the last centuries.

In order to determining the effects of planting density and first irrigation date on saffron yield this study was conducted on the experimental fields of Malayer University, in the west of Iran. The experiment was conducted as a split-plot design with four replications. Different times of first irrigation (August 30, September 15 and September 30) were allocated in the main plots and different corm densities (30, 60 and 90 corms per m^2) as the subplots.

The results showed significant differences between the planting densities with respect to the flower numbers, saffron yield and total dry matter. The correlation between saffron yield and corm density was positive, but the effects of first irrigation date on saffron yield wasn't significant. By changing the time of the first irrigation only the beginning of flowering, the duration of flowering and the total corm number were affected. In general, the results showed that the best corm density for producing an economical interested yield in the first year of saffron production was 90 corms per m^2.

Keywords: Irrigation scheduling, plant density, saffron

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The Use of a Non-corrosive Acidified Preservative for Moist Corn Storage under Philippine Conditions

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The potential action of organic acids under farm conditions in feed preservation and protecting feed from microbial and fungal destruction is already widely accepted in the agricultural business. The use of these acids will significantly reduce the microbial contamination of treated corn. This decontamination will furthermore secure the nutritional value of the stored corn and can therefore lead to healthy animals, good animal performance and ensure overall economic animal production.
Despite this, year on year the agricultural industry faces huge losses due to spoiled corn which was not properly stored and preserved after harvest. This holds particularly true for the tropical regions.
A trial was conducted in a commercial feed-mill in Batangas Province, Philippines, to validate the efficacy of a preservative containing sodium benzoate, propionic acid and sodium propionate (KofaGrain pH5) in the treatment of commercial quality corn. Corn with a moisture content of 13 % was treated with the supplier recommended dosage of the preservative (3.5 litre t^{-1}) and stored under simulated silo conditions in silo-shaped galvanized iron drums for 74 days. The temperature was recorded twice a day. Mold and yeast count was taken at the beginning, midterm and end of the trial period. For the treatment group, the initial mold and yeast count was 332,000 and 40,300 cfu g^{-1}, respectively. The preservative treatment yielded in a mold reduction of 82.9 %. This was significantly different compared to the control group ($p = 0.06$). At the same time, the application of the preservative on the corn yielded for the yeasts a reduction of 88.4 %. Again, this reduction level was significantly different ($p = 0.03$) from the control group. No corrosion was observed in the drums that were directly exposed to the preservative. The trial outcome suggests that the preservative (KofaGrain pH5) offers a viable system for long term corn storage under tropical climate conditions for small to large commercial corn traders, feed manufacturers and integrators.

Keywords: Acidifier, moist corn preservation, propionic acid, sodium benzoate

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Systems under stress

Land use and management

New Institutions and Technologies to Cope with Risk in Pastoral Systems – Pitfalls and Chances

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Pastoral systems worldwide undergo fundamental changes in the last decades. New institutions and technologies emerged to cope with variable and unpredictable climate and to adapt to changing socio-economic settings. Examples are the utilisation of supplementary feeding, long-distance mobility by use of trucks or the introduction of rain-index insurances. Besides intended effects of these new ways to reduce income risk, adverse non-intended effects may occur in these complex social-ecological systems.

Socio-geographic research on the High Plateau (Morocco) has shown that households are not a homogeneous group but rather differ in various regards. Policy instruments (such as subsidised supplementary feeding) to decrease income risk not help to reduce the polarisation of the pastoralists, if these instruments are not targeted to the marginalised group. However, for that purpose a comprehensive understanding of consequences of such instruments is in need.

Abstracting from this case study, we built a dynamic, stylized ecological-economic simulation model for a hypothetical grazing system to investigate the impact of the design of new institutions and technologies such as supplementary feeding on livelihoods and on pasture condition in long-term. Hereby we include explicitly the feedbacks between the ecological processes, human decision-making and socio-economic framework conditions.

Our results show that the timing of supplementation matters. As prior studies indicated, it is revealed that supplementation in drought years may increase long-term pressure on the grassland. Hence on short-term income risk may be reduced, but on long-term ecological degradation may occur. However, feeding strategies, which provide forage (additionally) in the years after droughts, when rainfall is not anymore limiting, are beneficial in ecological and economic terms as long as the additional forage is used to reduce pasture pressure but not to increase livestock number rapidly.

Finally we want to point out a general potential of our approach: We use modelling not to make predictions for the real world. We rather use it as a tool for communication, to make aware of intended but in particular also of non-intended consequences of different policies. Therewith we aim to support discussions on appropriate risk management strategies – for instance for marginalised natural resource users.

Keywords: Morocco, pastoralism

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Marginal Dryland Agriculture in Jordan: Forage Banking for Pastoralists?

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Cultivation of agriculturally marginal drylands can have disastrous effects on ecosystems and livelihoods. Counter-intuitively, the customary rangeland access system prevalent in Jordan's arid Badia region may in some cases mitigate such effects and in certain respects render them beneficial.

Jordanian Badu pastoralists typically rely on open access rangeland and purchased grain to maintain flock sizes. Livestock are often the main source of household income, and drought and high grain prices are often-cited threats to their livelihoods. However, government feed subsidies appear to have contributed to high livestock numbers, chronic overgrazing and rangeland degradation, such that a return to non-market subsistence pastoralism is ecologically infeasible at present.

There is little pre-emptive livelihood diversification within pastoralist households. Forage banking is not customary, with access to rangelands for pasture generally being open except at sites under current cultivation.

Farmers often cultivate rain-fed barley in locations with mean annual precipitation as low as 200 mm, where harvests are only possible in above-average rainfall years. In below-average rainfall years, pastoralists may pay to graze the failed crop at the end of the growing season. In the meantime, the cultural prohibition against grazing another person's cultivated land remains in force even in the absence of physical barriers such as fencing.

Thus, barley cultivation of marginal land can protect against persistent overgrazing, provide valuable vegetation cover in a region vulnerable to soil erosion, and help maintain pastoralists' flocks during drought-induced livelihood crises. While these interactions constitute only a small part of the overall human-natural system of the Badia, they should be considered when assessing and attempting to enhance the resilience of this system with respect to drought.

Keywords: Arid, Badu, Bedouin, livelihood, pastoralist, rangeland, tenure

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Aboveground Net Primary Production and Rain-use Efficiency in Drylands – Results and Insights from a Meta-analytical Perspective

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In drylands above-ground net primary production (ANPP) and rain-use efficiency (RUE) are common ecological indicators for assessing ecosystem's state, including degradation and supply of key ecosystem services. Despite their widespread and frequent use, both indicators have been challenged by strong critique, raising the question whether — and if: to what extend — these parameters can comply what they promised: being easy, fast and relatively cheap indicators and tools for ecosystems assessment and modelling. Both have been criticised as 'lumped' parameters, aggregating complex information and rendering clear interpretations impossible. Furthermore, literature still lacks a consensus about the response patterns of ANPP and RUE along precipitation gradients, which makes it difficult or even impossible to extrapolate them in space and time.

Taking advantage of a large body of studies from the last 50 years, we conducted a meta-analytical database for mid- to long-term monitoring and experimental studies from (semi-)arid environments. Data was analysed with meta-analysis and non-standard regression methods in order to render new insights and test assumed generalities. Meta-analysis was used to disentangle the influences of several ecological factors on ANPP and RUE, and enabled us to separate the impact of these factors into significantly distinct, quantitative effect sizes. Linear piecewise quantile regression was used to analyse the response of maximum ANPP and RUE along an arid to semi-arid precipitation gradient.

Meta-analysis shows that ANPP, and therefore RUE, are significantly affected by precipitation, different land use parameters, soil characteristics and biome type. Our results strongly suggest that usability as well as informative value of RUE as tool for ecosystem assessment and land management decisions would strongly increase if biome and soil characteristics would be accounted, rather than assuming general thresholds for this indicator. LPQR revealed that both parameters follow an unimodal trend along arid to semiarid precipitation gradients, peaking at relatively low precipitation values. The unimodal trend holds for different land use regimes and intensities, but varies along these with respect to total magnitude and the post-peak decline. Furthermore our found trend is able to reconcile the partially contradictory response patterns of ANPP and RUE found in literature.

Keywords: Drylands, meta-analysis, rain-use efficiency, rangeland ecology

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Poverty and Tropical Deforestation in Forest Margin Areas: Evidence from Central Sulawesi Indonesia

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Negative effects of climate change have made poverty and deforestation issues becoming important topics of global environmental discussion in recent years. It is still a challenge for many developing countries to disconnect poverty reduction from negative environmental effects including deforestation. Thus, more evidence from empirical studies is required regarding the impact of poverty on the rate of deforestation, especially empirical studies that provide more comprehensive approaches toward a poverty-deforestation link. This paper examines the relationship between poverty and deforestation in a tropical forest region in the vicinity of Lore Lindu National Park in Central Sulawesi, Indonesia. This park hosts a unique collection of endemic species, however, at the same time this region is characterised by a high rate of poverty and deforestation. Therefore, it is important to explore the link between poverty and deforestation in this region, in order to maintain the long term functioning of the forests and people livelihoods. To understand this relationship, we use a beta regression in our empirical model. Furthermore, poverty is a complex phenomenon. Thus, we include proxies of poverty from different dimensions as well as an index of subjective well-being (SWB) at the village level. Very little research on SWB has been done in developing countries and only a few have applied SWB as a proxy of poverty. Our analysis applies geo-referenced land cover data and socioeconomic data from 2001 and 2007, obtained from Landsat ETM+ scenes and surveys in 80 randomly selected villages, respectively. Our results suggest that there is a non-linear relationship between SWB as well as other proxies of poverty and deforestation. The improvement of well-being measured by the share of stone houses decreases the rate of deforestation in this region, but initially wealthier villages show a higher rate of deforestation. Other proxies of poverty such as literacy rates among villagers in the productive age also decrease deforestation. Our results are used to draw policy conclusions with respect to reduce forest loss. Therefore, to maintain the long term functioning of the agro-forest production system and thus to improve rural welfare, it is advisable that the policy options should be implemented.

Keywords: Beta regression, deforestation, poverty reduction, subjective well-being

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Applying Change Vector Analysis Method to Detect Vegetation Regeneration and Deforestation in Southern Darfur, Sudan

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The continuous extraction of wood and the conversion of forest to agriculture due to a rapid population growth (ca. 4.15 % per year) in southern Darfur State since the drought of 1985 are rapidly changing the natural vegetation cover of the Edd Al Fursan region. The main aim of the presented study was to assess the dynamics of the change of the natural vegetation cover during the period 1972 and 2008 in this area.
Multi-temporal Landsat (MSS, ETM) and ASTER data have been utilised to detect historical vegetation change using Change Vector Analysis (CVA) of Kauth- Thomas features representing brightness and greenness. The technique produced images that show the direction and the magnitude of the vegetation cover change between two dates based on the inputs of brightness and greenness. The direction of change indicate whether a landscape experienced deforestation, reforestation, or remained persistent. The magnitude indicate to what degree the change occurred.
Supervised classification has been used to quantify different land cover classes. The results of the study show that intensive deforestation as well as bare soil expansion occurred during the periods 1972-1984, 1984-1989, 1999-2008 and 1972-2008. Since the early 1970s drought conditions were present and human migration from northern to southern Darfur took place. Moreover, in recent years conflict and war pushed a very large number of the internally displaced persons (IDPs) into that area. As a result, many areas have been cleared from its forest cover either for agricultural purpose or for wood selling. The harvested wood was sold at local markets as fire wood or building material. In contrary, significant vegetation regeneration occurred during the period 1989-1999, which indicates that the environment recovered from the drought due to sufficient annual rainfall as well as due to a livelihood diversification of the local population. The study demonstrated the capability of the CVA to classify and quantify vegetation cover change in southern Darfur.

Keywords: Change detection, change vector analysis, land cover change dynamics

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Quantitative Accessibility Models in Evaluating Resource Use Patterns: Examples from the Peruvian Amazonia

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Physical accessibility is an important determinant of land use patterns both in urban and rural regions. In Amazonia, accessibility to urban centres and product markets is a key factor determining welfare of rural dwellers: economic viability of different livelihood choices, health care opportunities and educational possibilities are all affected by rural to urban transportation options. On the other hand, deforestation and exploitative resource use are often linked with enhanced accessibility. Thus, spatial patterns of accessibility are of great interest for actors aiming at improved human livelihoods or worried about the land use pressure on Amazonian protected areas and biodiversity. Although the relevance of accessibility questions in Amazonia is widely acknowledged, deeper analyses of accessibility patterns and their impacts on Amazonian people and environment are scarce.

We have developed a quantitative model for describing spatial variation of accessibility in the north-eastern Peruvian Amazonia (Salonen et al. 2011, accepted in Applied Geography). In our presentation, we discuss the applicability of such a model by introducing two case studies from NE Peru. First, we compare the effects of different transportation network types on regional accessibility patterns. We demonstrate how livelihood choices and resource use patterns along road networks differ from those along dynamic river systems. This is particularly topical now that considerable investments for infrastructural improvements are planned in the Amazon region. Secondly, we show how accessibility is a powerful predictor of land use change in the Amazonian lowlands. A particular focus is given to the importance of quantifying accessibility in a meaningful way – not just relying on Euclidean distances that so far have been the primary measures of accessibility in Amazonia.

Keywords: Accessibility, Amazonia, livelihoods, resource use

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Building Geoprocessing Models for Land Suitability Assessment for "Thanh Tra" Pomelo in Central-Vietnam

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A land suitability assessment study for "Thanh Tra" pomelo production in Central Vietnam was carried out in the Nam Dong district, Thua Thien Hue province. GIS technique was applied following the framework for land evaluation (FAO, 1976) in order to facilitate the spatial analysis to achieve an optimum utilisation of the available land resources for the sustainable pomelo production. The multi-criteria evaluation method was used based on the climatic and terrain data as well as soil properties. The minimum area of evluation was a pixel with the resolution of 30×30 m. Eight parameters for crop suitability and five parameters for environmental suitability were considered and the suitability analysis was carried out by fuzzy membership classification. In addition, this study also incorporated farmers' perceptions as well as their preferences into the decision making process by using analytic hierarchy process (AHP). Geoprocessing models were built using Model Builder Extension in ArcGIS to excuse the sequence command to generate a physical suitability index map for "Thanh Tra" pomelo in the study area.

The physical suitability of "Thanh Tra" pomelo map showed that there were no highly suitable areas. The highest suitability percentage belonged to marginally suitable that accounted 11,057 ha or for 53.30 %, followed by moderately suitable with an area of 9,619 ha or 46.37 %, while the non-suitable area accounted only 70 ha or 0.34 %. The results of this study can be used as recommendation for the farmers and responsible administrators in the region in order to change the cropping patterns for pomelo orchards, for higher productivity and less negative impact on the environment.

Keywords: Geoprocessing models, GIS, land suitability assessment, multi-criteria analysis, "Thanh Tra" pomelo

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Nuclear Techniques to Investigate Carbon Source/Sink Dynamics between Areas of Land Degradation and Deposition Areas in Local Tropical Watersheds

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Innovative technical and progressive approaches are strongly required to adequately trace soil organic carbon (SOC) sink-and-source relationships between areas of critical land degradation and deposition areas. This is particular crucial for mountainous landscapes of northern Vietnam where rapid land use changes are responsible for severe and accelerated land degradation. Consequently, this agricultural intensification in upland areas is leading to rampant water erosion promoting severe losses of SOC and therefore it is of central importance to study such sink-and-source relationships between areas of critical land degradation and also deposition areas in the lowlands.
In this study we use a compound-specific stable-isotope (CSSI) approach to investigate source-and-sink relations of SOC in the Chieng Khoi catchment, Son La Province, Vietnam. The CSSI approach uses natural abundance signatures of plant-specific carbonaceous compounds, such as δ^{13}C values in fatty acids (fatty acid methyl ester – FAME) originating in upland soils in the studied tropical catchment including a range of different crops (*e.g.* maize, cassava), as well as natural and secondary forests. These CSSI-biomarkers will be traced in the lowland soils (i.e. paddy rice soils, lake sediments) to estimate the dynamics of landscape SOC stocks at catchment level and to assess how land use intensification has changed the spatial and temporal distribution of respective C from uplands to lowlands. So far no attempts have been made to use natural abundance signatures of specific organic compounds (*e.g.*, δ^{13}C values in plant-derived fatty acids) in the soil profile to identify soil sources and to apportion their relative contribution from different land use sites in tropical watersheds including a range of farming systems.
In the presented study we discuss primarily the applicability of CSSI analysis and CSSI-based mixing models to identify and trace SOC source-and-sink dynamics in a local tropical watershed on a temporal and spatial scale.

Keywords: Compound specific stable isotopes, fatty acids, soil erosion, soil organic carbon dynamics, Vietnam, watershed

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Multi-criteria Assessment of Landscape Vulnerability and Land Use Potentials in Central Vietnam

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The Quang Nam province in Central Vietnam is highly impacted by the ongoing land use intensification, hydropower plant construction, establishment of a power supply network, gold mining and other activities promoting the economic growth of the province. These activities led to the expansion of the road system, of agricultural land use and of settlements and therefore to the fragmentation of natural landscape causing biodiversity loss, soil erosion and also contamination of soils and rivers. The present study aims at determining the vulnerability of the province's landscape and its future land use potentials.

The multi-criteria assessment of landscape vulnerability considers three important forms of landscape degradation in the region: soil erosion, forest degradation, and surface water contamination. Landscape vulnerability to soil erosion is assessed on the basis of the USLE-equation using secondary data and field data, including interviews with farmers and field observations for the consideration of management practices. The vulnerability of forest ecosystems is classified by means of the Vietnamese forest classification (rich, medium and poor forest, bare land forested and bare land classes) under consideration of vulnerability parameters for these forest types. Furthermore, areas with high vulnerability to water contamination, such as headwaters, floodplains, and wetlands are recorded. By combining the different layers, a vulnerability map is generated. This map pinpoints the areas which are most vulnerable and thus are in highest need of protection. The map also shows those areas for which more sustainable land use alternatives have to be developed.

Based on the different landscape vulnerability classes, recommendations for suitable land use practices are given. The obtained results provide guidance for land use planners and farmers in the Quang Nam province for a more sustainable use of the natural resources.

Keywords: Forest degradation, land use potential, soil erosion, vulnerability

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Rapid Soil Resource Survey Using Radiometric Signatures

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Climate change and human activities are responsible for a shift in properties and spatial distribution of soil resources. In order to monitor such changes, more quantitative and multi-temporal soil mapping methods are required. Classic soil surveys based on field augering and laboratory analyses are costly and time consuming. This calls for more rapid soil mapping methods, among which gamma-ray spectrometry is one option, as it is not solely depending on surface reflection but detects gamma-rays produced within the top 0.5 m of the soil, thus providing also subsoil information.

The objective of this study was to investigate the potential of gamma-ray spectrometry for mapping soils and soil properties under consideration of soil parent material. Therefore, the radioelement signature (K, eTh, eU) of soils from different parent materials (limestone, granite, gneiss, sandstone, and claystone) in N-Thailand was investigated.

Results reveal that the radioelement signature can be used to distinguish different reference soil groups according to the World Reference Base for Soil Resources (FAO 2006). The prediction accuracy using classification trees of Acrisols, Alisols, Chernozems and Ferralsols was well above 90 %. Additionally, occurrences of Umbrisols and Cambisols were predicted with 77 % and 64 %, respectively.

Especially, the potential of gamma-ray spectrometry to distinguish different clay illuviation soil types in the field (*e.g.* Acrisols vs. Alisols) is of paramount interest, since it can replace costly and time consuming laboratory analyses.

In addition, gamma-ray spectrometry offers an option for multi-temporal mapping via airborne remote sensing. A first comparison of airborne gamma-ray with classic soil survey data of a limestone area is promising. However, the relation of ground-based with airborne measurements needs further reflection.

Keywords: Classification trees, gamma-ray, northern Thailand, pedology

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Object-based Land Cover Mapping of Multi-Spectral Imagery in semi-Arid Areas

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Effective management of fragile ecosystems requires flexible, reliable and up-to-date information. Due to complexity and spectral similarity in low-cost, medium resolution remotely sensed data acquired over semi-arid areas, land cover mapping encounters serious problems. To cope with this issue, an innovative object-based (OB) image analysis paradigm was applied to evaluate the effectiveness of generating land cover maps based on EO data. The test site is located in the Blue Nile region of Sudan, where accurate information of the current distribution of land cover patterns is seriously needed in order to solve severe environmental problems associated with over-exploitation of natural resources. Multi-spectral ASTER satellite imagery data acquired in March (2009) is geocoded with a Root Mean Square (RMS) less than 0.5 of pixel size. Different segmentation strategies were tested with the OB paradigm that might be effective to separate similar spectral values into preliminary unclassified image objects of groups of relatively homogeneous pixels based on shape and compactness criterion at different scales. Subsequently, segmented objects were assigned to different land cover classes by methods of Rule Based (RB) and Nearest Neighbour (NN) classifiers implemented in eCognition software using knowledge-based and randomised Training and Test Areas (TTA) Mask respectively. These methods applied spectral, shape and contextual relationships between the objects, and allowed for the separation of nine land cover classes, including agriculture (rain-fed), dense-forest, grassland, horticulture, irrigated croplands, bare-land, scattered-forest, settlements, and water. An error matrix based on collected field samples was calculated, and proved for high overall classification accuracy (98 %) concerning the method of RB classifiers, while NN classifiers achieved about 76 % accuracy. The study demonstrates the effectiveness of the combination of different parameters for segmentation, and of a set of optimal features used, as well as the flexibility of hierarchical data processing strategy. To conclude, an evaluation of the results obtained is promising, and indicates that OB paradigm has a great potential for solving problems of multi-spectral remote sensing image classification in semi-arid areas.

Keywords: ASTER, image segmentation, land cover, object based classification, semi-arid area

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Mapping Cropland Marginalisation in the Downstream of the Amu Darya River, Uzbekistan

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In Uzbekistan, where about 16 million people depend on irrigated agriculture, cropland marginalisation due to water shortages, soil salinity and eventual withdrawal of unproductive fields significantly affect agro-ecosystem services and economic growth. The challenge of simultaneously maintaining sufficient agricultural production and environmental sustainability can be addressed via setting aside marginalised cropland parcels for ecological restoration. Such approach requires spatial assessment of degraded croplands where remedial practices need to be applied. This study therefore aimed at developing a remote sensing based method for mapping land degradation (LD) trends in the downstream of the Amu Darya River, Uzbekistan. LD was defined as a long-term decline in vegetation biomass, measured using the normalised difference vegetation index (NDVI) as a proxy. Satellite images from the Moderate Resolution Imaging Spectroradiometer (MODIS) were used to calculate the NDVI time series for the period between 2001 and 2009. An adaptive Savitzky-Golay filter was applied to distinguish between inter-annual long-term biomass changes and short-term seasonal variability in the time series. The filtered NDVI images were tested for the presence and magnitude of the LD trends, applying the non-parametric Mann-Kendall test. The analyses revealed that the croplands experiencing LD were mainly located in the north-east of the study area, covering about 13 % of the territory. The resulted degradation severity map agreed well with an independent spatial assessment based on yields as an indicator of the cropland marginality. An evaluation of our findings showed that the decline in vegetation biomass was mainly restricted to peripheral locations with crop rotation under fallows. The results of this spatial assessment can be applied in developing remedial land use options for the degraded marginalised areas, such as afforestation with well-adapted tree species capable of high biomass production under saline conditions.

Keywords: Marginal cropland, MODIS time series, NDVI, remedial land use, Uzbekistan

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Assessment of Biomass Production Potential on Salt-affected Land. A Soil and Terrain Database Case Study (SOTER), Badin District, South of Pakistan

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Good and appropriate advice to biomass production potential on salt-affected land requires a good knowledge of soil resources and soil salinity/alkalinity. The decreased site productivity calls for an information system on soil resources, which permits the analysis of land suitability, potential production for food and energy, environmental impact of land use and identification of suitable measures. The data structure for the delineation of the land resources was organised according to the Soil and Terrain Digital Database (SOTER) manual, which includes observations, analytical attribute data and GIS based spatial terrain data. On the highest level, five so called terrain units could be distinguished. The main differentiating criteria were landforms, degree of salinity/sodicity and groundwater level. The Badin District, southern region of Pakistan is characterised by an arid tropical climate. A soil and digital database was established to evaluate the ability of land units to support crops and tree production. Soil transects and a topographic map was combined to provide information on spatial variability of salt affected soils, terrain type, and land use. The FAO/ITC (Land Suitability Classification) was used to identify crop specific constraints to salt tolerant tree (*Eucalyptus camaldulensis*, *Prosopis juliflora*, *Acacia nilotica*) and crops (cotton, rice and wheat) production. The land index of salt affected soils in the study area turns out to be moderately suitable to unsuitable for selected crops and trees. The results show that the low index values are due to chemical limitation levels (degree of salinity, sodicity, and organic carbon). In addition, unfavourable climatic conditions determine the suitability of the region for crops and tree production. The ranking of the suitability and biomass/yield potential of the crops for Badin District was in the order cotton $<$ wheat$<$ rice, and for the trees *Prosopis* $<$ *Acacia* $<$ *Eucalyptus*. Appropriate management and possible crop and tree species selection by farmers increase the yield potential significantly. The results obtained from this study indicate that the integration of GIS and application of FAO Ghent Evaluation could provide a good database and guide map for decision maker determined crop substitution in order to achieve better agricultural production.

Keywords: Badin, land evaluation, salt-affected land, SOTER

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Evaluating NDVI as a Tool to Monitor Grasslands' Encroachment in Corrientes, Argentina

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Grasslands in the Province of Corrientes occupy around 50 percent of the total area and constitute the main source of energy, proteins and fiber for livestock. Livestock keeping is in turn the most important agricultural activity in the province.

Typical grassland management strategies in the region comprise: first, the regulation of grazing intensity and second, the use of fire to induce early sprouting of grasses and to control non edible plants. Fires, however, may not suppress weeds species having deep tap roots or tubers and indeed could help them to spread, once other fire-sensitive species disappear.

The goals of this study were to compare the density of *Vernonia chamaedrys* Less. in paddocks under different management and to evaluate the Normalized Difference Vegetation Index (NDVI) as a tool for grassland encroachment studies. NDVI measurements were obtained using a field radiometer. A two stage sampling design was established in two neighboring farms located in "El Sombrero", northeast region of Corrientes Province. Two treatments were evaluated: application of fire every two years *vs*. no fire application. Paddocks were located on same soils with similar vegetation and grazing intensities (0,94 to 1 animal units per hectare for the last three years). Neither herbicides nor fertilisers were applied

Dataset of the variable "Density of *Vernonia chamaedrys* plants" had to be transformed in order to adjust to a normal distribution. The results of the comparison of means using a T-test show that both, density of *V. chamaedrys* and NDVI were significantly different between treatments ($p < 0,0001$; $\alpha = 0{,}05$). However variation in NDVI values could not be attributed to variation in plant density, as indicated by the low correlation coefficient obtained: $R^2 = 0{,}18$.

These results suggest that for the conditions of this study even though NDVI was able to reflect changes, it would not be a highly sensitive tool to identify the encroachment with *V. chamaedrys*. More studies involving other species to find better responses on variation of NDVI values are considered necessary.

Keywords: Encroachment, grasslands, NDVI, *Vernonia chamaedrys*

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A Qualitative Expert Assessment Tool (QAToCA) for Assessing the Adoption of Conservation Agriculture in Africa

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Adoption rates of Conservation agriculture (CA) in Africa are very low as compared to those in South and North America or Australia. However, CA is seen as a solution to overcome continuing poor farm profitability and soil degradation in Africa. It is based on three agronomic principles: (1) to minimise mechanical soil disturbance; (2) to maintain permanent soil cover with organic mulch; and (3) to diversify crop rotations.

Some studies that aim at identifying the determining factors of CA adoption in Africa have become available in the literature. However, a comprehensive self-assessment tool is lacking that allows a systematic evaluation of the determinants in the CA adoption process from field, farm to regional scale and for use in a variety of regional contexts. We therefore developed a Qualitative expert Assessment Tool for the assessment of CA adoption (QAToCA) within the EU funded project 'CA2Africa' (www.CA2Africa.eu).

Guided by existing diffusion theories and conceptual models of adoption, QAToCA is designed to assess in a semi-qualitative manner the socio-economic, institutional and cultural conditions that promote or hinder the adoption of CA in the heterogeneous farming contexts in Africa. QAToCA contains a systematic, expert-based list of adoption criteria with associated questions and possible scenarios for regional CA experts and practitioners to self-assess their CA diffusion activities.

This paper presents the QAToCA tool and reports on the first applications in two African case studies, located in the Bungoma and Karatu districts in Kenya and Tanzania, respectively. The case studies are part of the CA-SARD project that was funded by FAO and coordinated by the African Conservation Tillage network (ACT) with the main objective to improve food security and rural livelihoods of small and medium scale farmers by promoting CA. Main interventions were the adaptation and testing of CA technologies through approaches that included farmer field schools, field days and exchange visits aiming at capacity building and creating awareness. The comparative analysis yielded in a better understanding of the specific regional socio-economic, cultural and institutional settings that determine adoption of CA and can help in targeting CA technologies within smallholder farms in the region.

Keywords: Adoption potential, Africa, conservation agriculture, expert assessment tool

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Agriculture and the Rural-Urban Continuum – GIS-based Analysis of Urban and Periurban Agriculture in Moshi, Tanzania

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As shown by a wide range of research activities within the last years, urban and periurban agriculture can contribute to the overall food security of cities in Africa. Furthermore it shapes the socio-economic situation of urban and periurban farmers as well as it plays an important role in the spatial development and planning efforts in cities. Even though research on this topic has grown recently, there still is a notable bias on capital cities and the main economic centres while medium-sized cities have been widely neglected.

This case study concentrates on the changes of the importance of urban and periurban agriculture along the rural-urban continuum in medium-sized Moshi, a municipality of about 180.000 inhabitants located on the foothills of Mt. Kilimanjaro, Tanzania. A twofold approach was applied to get a comprehensive data set on the importance of agriculture for the livelihoods of Moshi´s inhabitants on the one hand and to get data about the change of land use patterns along the rural-urban continuum on the other. Therefore four transects from the city centre to the periurban areas of Moshi have been identified, each eight kilometres long and a hundred meters wide. Within those transects, a GIS was applied to sample about 400 households that were interviewed with a standardised questionnaire to assess the importance of agricultural activities for the individual households. Secondly, the land use patterns within the transects were mapped using high-resolution satellite imagery and *in situ* methods. After combining the geocoded household data and the information on land use in a GIS, a comprehensive Agricultural Activity Index could be developed for every respective scale unit along the continuum. In a next step, the index values were spatially analysed using other spatial information such as construction activity and social data (*e.g.* household income, household assets, tribe) in order to identify correlations. Supported and visualised are these findings by a GIS-based analysis of the gradient of agricultural activities from the city centre to the surrounding areas.

Keywords: Agricultural activity index, geographic information system, Moshi, rural-urban continuum, urban and periurban agriculture

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Using Land Change Modelling Based on Satellite Images to Assess the Resilience of Land Use Systems

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In the frame of the ReACCT project (Resilient Agro-landscapes to Climate Change in Tanzania), the project team examines the resilience of manmade agricultural production systems in the Morogoro region of Tanzania in relation to the predicted changes in climate until the year 2100. One aspect is the influence of the land use change on the resilience of the agricultural production systems. To be able to assess this influence, results of an in-project land use classification based on Landsat satellite images from different decades have been used for a Land Change Modelling (LCM) approach. The LCM is part of the IDRISI software package. In a first step the land use changes between 2000 and 2010 have been determined for most wards (administrative units) in the Morogoro region. In- or decrease of the area of land use classes, but also transitions between classes could be determined using this method. For example, in ward Mabwerebwere shows a moderate transition from the land use class scrubland to agricultural land, while a slight increase of forest could be noticed. In the ward Mikese a significant amount of the grassland was converted into agricultural land, whereas in the ward Mvomero the total amount of agricultural land area was reduced between 2000 and 2010, probably due to no longer cultivated sisal plantations. These data can provide valuable information for local administration and future land use planning. In a next step satellite images from 1991 and 1985 will be added to allow the simulation of future land change scenarios. The results of the simulation will be combined with the results of a crop production scenario based on climate prediction and crop models. The combination of these methods allows the concurrent consideration of different drivers influencing the resilience of the agro-landscapes in the Morogoro region of Tanzania and can provide valuable data for future planning of adaptation strategies to climate change.

Keywords: Land change modelling, land use change, Landsat, ReACCT, resilience

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Exploring the Influence of Socio-economic Aspects on Realising Agricultural Production Potential in sub-Saharan Africa (by using Maps)

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In order to ensure food security and reduce poverty, one of the key challenges is to raise agricultural productivity and production in developing countries. Domestic agricultural production productivity growth plays an important role since it will help developing countries to become less dependent on imports and hence less affected by price volatility on world markets, like during the recent crisis. In addition to biophysical factors, such as soil quality and rainfall for example, prevailing socio-economic aspects are crucial determinants for the realisation of the potential agri-food production and ensuring productivity growth. The paper proposed combines research about plant production and an economic analysis, thereby constituting an interdisciplinary research effort.

The paper proposed looks at socio-economic aspects and agricultural productivity in sub-Saharan Africa as a case study. For sub-Saharan African countries, we collect data on indicators reflecting socio-economic aspects and examine them in a comparative analysis across countries by using maps. The aim of our analysis is to shed light on the relationship between socio-economic aspects and agricultural production. More specifically, we will explore the influence of socio-economic indicators on difference in the actual yields harvested and potential yields, given the prevailing biophysical conditions.

In the first part of the paper, we introduce a set of socio-economic factors and derive indicators that can be used for their measurement: farm-level aspects, socio-economic aspects, market access and governance/market institutions. While some of the socio-economic indicators are of general nature, others have a clear link to agriculture and range from primary production and inputs to the distribution of food products. The socio-economic indicators are applied in the subsequent analysis to explain "yield gaps". The paper finishes with a discussion and concluding remarks that will also consider the challenges of the analysis.

Keywords: Agricultural production potential, maps, socio-economic indicators, sub-Saharan Africa, yield gap

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Models of Development and Marginality in Drylands of Argentina's Central West: A Case Study in Mendoza Province

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Argentina's Central-West encompasses a vast dryland territory – a rain shadow desert lies West of the Andes Range – organised on the basis of a contradiction: the confrontation between oasis and rainfed area, that is, desert lands with no irrigation. In a territory under conditions of total aridity with different desertification levels, the province of Mendoza is a paradigmatic case.

The development model of Mendoza fostered by dominant groups at the end of the XIX century was based on the supremacy of two strategic resources: water and soil. The regional development was strongly orientated on the enhancement of irrigated lands in order to consolidate the wine exporting model.

Nowadays, Mendoza's non-irrigated lands and their population are marginalised not merely by the effects of a restrictive environment but also by the combined action of a limited, fragile physical support and the weightier social, political and economic forces that have banished them to the system's margins. The analysis of the region's history informs that non-irrigated lands provided both strategic natural resources for the development of irrigated areas and as possibilities to start production activities. Simultaneously, non-irrigated lands were restricted in their rights to access strategic resources for their social reproduction (water, land and identity).

This contribution delves further into the analysis of the dynamics of territory construction whereby some territories hold a central position while others are relegated to marginal positions. Further, a regional case study shows the efforts of a group of social actors – local communities, scientific sector, national, provincial and local governments – to encourage a rural development strategy for non-irrigated drylands to allow full inclusion of these territories as well as their actors as rights-bearing subjects. In the light of the results obtained, also the concepts of marginality, inclusion and periphery are discussed as applied to the case study.

Keywords: Argentine's drylands, marginality, models of development

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Mapping and Monitoring Land-cover/Land-use Change in the Gash Agricultural Scheme (Eastern Sudan) Using Remote Sensing

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The Gash Agricultural Scheme (GAS) is considered as one of the pilot projects that contribute to the rural development in eastern Sudan, particularly towards local population around the Gash River area. In the last decade, the scheme has undergone serious deterioration, further drought spells have led to increased pressure on meagre resources, in addition to invasion of unfavourable Mesquite trees. These factors lead to acceleration of the degradation process in the study area. This study is attempted to monitor and to assess the impacts of land degradation process on GAS area. For that, four cloud free multi-temporal Landsat images of the years 1979, 1987, 1999 and Aster data of the year 2010 covering the study area were selected for analysis. Maximum Likelihood Classification (MLC) method was used for the image classification. Five land cover/land use classes were identified explicitly; Mesquite trees, grass land, clay soil, stabilised sand and mobile sand. Visual and statistical change detection was carried out to detect the respective land use and land cover changes for the area. The results show that stabilised sand and mobile sand are the most dominant classes within the study area. They extremely affect the agricultural and residential areas as well as threaten the Gash River course during the dry season. Furthermore, the stabilised sand and mobile sand increased at the expense of the vegetation cover. The results also revealed that a rapid decrease of agricultural areas was observed over time as a result of Mesquite trees expansion. The study concludes that remote sensing provides important tools for generating and analysing information on land degradation status and its geographical extent in the semi-arid area of the GAS of Eastern Sudan.

Keywords: Gash agricultural scheme, land degradation, mapping and monitoring, remote sensing, Sudan

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Land Use Change and Hydrological Response in Code Watershed, Yogyakarta, Indonesia

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Uncontrolled land conversion from agricultural to non-agricultural area still remains one of the major problems in Yogyakarta, Indonesia. High population pressure and increasing demand for land cause the cultivation of marginal land and new settlements at risky sites such as Code River Area. This land use change has direct and indirect impact on hydrology such as a variability of stream discharges and infiltration processes, a change in water quality and it sometimes can even led to flood events at some parts along the river.

One of the environmental aspects which have affected by this land use change is hydrologic condition. The objectives of this study were to assess the impact on land use change in Code Catchment, in relation with the hydrological response. This response can be obtained by using available hydrological data mainly rainfall data and stream discharge data. Hydrological models can be used to predict the effects of the land use change on hydrological response of a certain catchment or region. In this case, change detection from satellite imagery was mapped using GIS software, and predicted for the next 15 year. Additionally, hydrological model SWAT (Soil and Water Assessment Tool) expected to quantify the effects from the land use change by using results from land use projection and several land use scenarios. This model is already used in several research projects to determine the effect of land use change and land cover on the water balance.

Based on the data, the value of the average flow coefficient is 52.56 % in the case study area in 2002. This means that nearly half of the rainfall amount changed into a surface flow. The high value of the flow coefficient resulted from the influence of physical conditions such as changes in land use pattern from agricultural land into non-agricultural land. The high flow coefficient in the upstream region indicates that land use changes have taken place and that these have an impact on the amount of surface flow. These conditions endanger the downstream areas, especially areas of densely populated urban settlements along the riverbanks.

Keywords: Code River, hydrological response, land use, Yogyakarta

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Grazing Patterns in Relation to Grazing Intensity and Management System

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The selective grazing of sheep influences sward structure by inducing heterogeneous vegetation patterns that differ in sward height. For example some areas are favoured by sheep, and others are permanently avoided by them. Those pastures exposed to high grazing pressures have an increased risk of degradation, especially in semiarid grassland. However, overgrazed patterns can also be found in plots with low grazing intensity and are not only related to stocking rate but also to the management system. The present study investigates the effect of different grazing intensities and management systems on grazing patterns.

The study site is located in the semi-arid, native grassland within the Xilin River catchment, Inner Mongolia Autonomous Region, P.R. China (43°38' N, 116°42' E). In two replicates three different grazing intensities and two different management systems were tested. In the Mixed System (MS), annual alternation between grazing and hay making was applied, while in the Traditional System (TS) the same area was always used either only for grazing or hay making. The 2-ha sizing plots were structured with a 10×10 m grid to analyse the vertical and horizontal distribution of the vegetation. The grazing patterns were assessed by height $\times$ density measurements at each 10×10 m grid point using a Rising-Platemeter (GRASTEC). Data were georeferenced and digitised.

High grazing intensity led to lower heterogeneity compared to the less intensively grazed plots. The biomass distribution maps illustrate overgrazed patterns (*i.e.* areas of low vegetation cover) in low grazing intensity plots. Patterns were more heterogeneous in the TS compared to the MS. This behaviour led to highly overgrazed patterns resulting in rising heterogeneity in the TS. Annual alternation between hay-making and grazing reduced such heterogeneity in the MS.

The vertical and horizontal structure of plant biomass was influenced by both grazing intensity and management system. The MS was more homogenous in terms of aboveground biomass distribution with less pronounced heterogeneous grazing patterns. These results suggest that management system may be as important as grazing intensity for sustainable management of semiarid grasslands.

Keywords: Grazing pattern, semiarid grassland, sheep grazing, vegetation maps

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Phytoremediation of Contaminated Farmland with Heavy Metals by *Eucalyptus* Cultivation in Iran

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Farmland can be contaminated with heavy metals as a result of industrial activity, posing a risk both to human health and to the environment, restricting the use of such land and thereby its value. Remediation may be possible by chemical means, or by burial of the contaminated soil, but this is expensive and seldom undertaken for large areas suffering from low level contamination. Phytoremediation strategies focus on the accumulation in above-ground plant parts and removal from the contaminated site. The production of biomass fuel crops on such land can bring it into economic use, result in an aesthetic improvement, and potentially lead to long-term remediation through heavy metal removal in the harvested crop. The production of biomass fuel crops on degraded land has several advantages as a site remediation measure. Production of a low risk, non-food crop on otherwise unproductive land brings that land back into the local economy.

Eucalyptus spp. were tested for their use as a sustainable and cost-effective management option of soils polluted with heavy metals. This study was carried out in the northern Province of Golestan and the southern Province of Khuzestan during 2007 to 2011.

This study indicated that biomass production is a key contributor to bioaccumulation and is the main factor for phytoremediation and for clean up of an environment polluted with heavy metals. Results showed that *Eucalyptus camaldulensis* is the most efficient accumulator under field conditions of Golestan Province. Potentially *Eucalyptus* spp. may be used for the *in situ* decontamination of soils polluted with heavy metals.

Keywords: *Eucalyptus*, Golestan, heavy metal, Khuzestan, phytoremediation

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Does Phosphorus Deficiency Aggravate Pasture Degradation in the Forest Margins?

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Pastures are the main land use throughout the deforested areas in South America including the forest margins of the department of Caquetá, Colombia. Pasture degradation induced severe loss of plant biomass production (PBP) with drastic ecological and economic implications. Highly weathered tropical soils usually have low phosphorus (P) contents, but the importance of P deficiency in pasture degradation has not been well defined. Our objectives were to determine i) whether P availability is lower in degraded pastures compared to productive pastures, and ii) whether the introduction of legumes in the pasture increases P availability through enhanced biological P cycling through plants, plant litter and the soil microbial biomass. An on-farm study was conducted in 2010 on nine farms in the department of Caquetá, Colombia. On every farm three different pasture types were studied: degraded grass alone pastures (GD), productive grass alone pastures (GA) and productive grass legume pastures (GL). Basic soil characteristics and indicators on soil P status, microbial P cycling, PBP, plant litter deposition (PLD) and nutrient concentrations in plant tissue were determined. Degraded grass alone pastures were characterised by significantly higher soil bulk density in the 0–5 cm soil layer and significantly lower soil gravimetric water content, PBP, PLD, soil organic P and basal soil respiration rate than GA. Moreover, per unit soil mass clear trends towards lower total carbon, nitrogen, total P and microbial P and higher Al saturation could be observed in soils of GD compared to GA while available soil P content and P concentration in plant biomass did not differ. No significant differences were found in any of the measured parameters between the two productive pasture types, GA and GL. Biological P cycling was clearly reduced in GD compared to GA while it was not substantially affected by the presence of legumes in GL. In the presentation we will show the importance of biological P cycling in sustainable pastoral systems and explain why it is important to include several soil and plant indicators to define the role of P in pasture degradation. The potential and limitations of on farm studies will be discussed.

Keywords: Biological cycling, degradation, pastures, phosphorus

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Remote Sensing and GIS for Assessing Land Use Land Cover Change: A Case Study of Jos and Environs, Plateau State Nigeria

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Given current population trends and projections in Nigeria, it is anticipated that substantial intensification of agricultural cropland is certain within the next decades. In the absence of adoption of improved technologies poor rural populations in this region will continue to degrade and mine the natural resources to ensure their livelihood. With pressure of increasing population, however, more agricultural land is needed and urban areas will expand. As a result, forest areas have already declined at an alarming rate. In response to this, there has been increasing research and development for sustainable forest management. This study has been conducted to assess the loss of forests (natural vegetation) and the alteration of land use cover in Jos and its environs using satellite based data sources between 1986 and 2007. The results of the analysis showed a tremendous decrease in natural vegetation from 33.59 % in 1986 to 27.09 % in 2002 and 9.70 % in 2007 which is attributed to population upsurge, climate change and poverty. The results of the study also reveal an increase in built up areas from 9.16 % in 1986 to 20.29 % in 2002 and 36.81 % in 2007 and also an increase in cultivated areas from 22.77 % in 1986 to 40.01 % in 2002 and a slight increase to 41.75 % in 2007. The study suggests that extents and intensities of land cover change in Jos is as a result of chronic hunger and a high level of poverty, which is accelerating the uncontrolled increase in population growth combined with negative impact on the vegetation cover. The study confirms the need for timely and reliable information based on the integration of remotely sensed data for management decisions and national policies aiming at preventive and remedial vegetation conservation and protection in Jos, plateau State Nigeria.

Keywords: Jos, land use land cover, Nigeria, remote sensing

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Effects of Bush Clearing, Prescribed Fire, and Grazing on Herbaceous Vegetation in Savannas of Southern Ethiopia

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The dynamics of bush encroachment worldwide has often been implicated for the loss of herbaceous vegetation in savannah ecosystems, and is associated with a decline in forage production. Various management prescriptions have been considered in order to restore herbaceous vegetation and improve forage production. This study was designed to evaluate effects of combinations of different treatment factors including hand clearing, prescribed fire and grazing compared to the control treatments on responses of herbaceous vegetation variables in the savannahs of southern Ethiopia. Field experiment was conducted on two ranch sites at different locations and altitude ranges over a period of 2 years between November 2003 and June 2005. The study consisted of five treatments: (1) the control treatment (CC+CF+CG-T1); (2) Hand clearing + prescribed fire + no grazing (C+F+CG-T2); (3) Hand clearing + prescribed fire + grazing (C+F+G-T3); (4) no clearing + no fire + grazing (CC+CF+G-T4); (5) no clearing + fire + grazing (CC+F+G-T5); and (6) Hand clearing + no fire + no grazing (C+CF+CG-T6). The ungrazed treatments were fenced and protected from grazing, while grazed treatment plots were unfenced and open to grazing.

Hand clearing and prescribed fire with no grazing (T2) resulted in significant increases in herbaceous biomass, density, basal cover of perennial grasses, species richness and diversity, particularly during the second phase of the post- treatment effects. Herbaceous vegetation variables were increased during the second phase of post- treatment effects with all treatments (exception being biomass, density and basal cover with T4 and T1). Generally, our results showed a significant increase in terms of herbaceous biomass and basal cover with T2 and T5 during the second phase of post- treatment. A similar level of response was recorded for herbaceous density with T3, while more species richness and diversity were recorded with T4 and T6. This finding suggests that fire treatment with grazing adversely affected herbaceous vegetation, specifically biomass, density and basal cover soon after treatment. Thus, following fire treatment, exclusion of grazers from burned areas is required to provide herbaceous vegetation the opportunity to restore.

Keywords: Grazing, hand clearing, herbaceous vegetation, prescribed fire, southern Ethiopia

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Exploiting Economies of Scale in Utilisation of Marginal Lands: The Case of Narok County, Kenya

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Agriculture is a major driver of Kenyan economy contributing over 25 % of the gross domestic product (GDP), directly and indirectly employing over 80 % of the working population. Located in the South of Rift valley region Narok County is facing increased land scarcity mainly attributed to burgeoning population. Livestock production through pastoralism is the main economic activity of the indigenous communities. The County earns massive revenue from wheat and barley farming and tourism every year. However, despite these huge revenues degradation of marginal lands, forests and water resources is evident; poverty is widespread and infrastructure is poor. The proximate major cause of land degradation is land overstocking due to communal nature of land ownership. Additionally, farming of fragile lands accelerates degradation. Due to the foregoing a study was designed to seek a more optimal and sustainable way of utilising land resources in the region. Economies of scale were postulated to provide an exit for the dilemma. The study sought to analyse how better the county can realise optimum output from the marginal resources while ensuring their sustainability. The study also analysed how locals can benefit more from economic activities involving marginal resources. The data for the study was collected from primary sources using questionnaire and structured interviews. Questionnaires were administered to subjects drawn randomly from small and large-scale farmers while interviews were conducted on the Ministry of Agriculture. The main finding of the study is that cultural practices play a significant role in land use patterns among the locals. The main cultural aspect is pastoral activity of keeping huge herds of cattle which is seen as a source of wealth. This activity contributes significantly to land degradation, given the little rainfall received during the year. Based on the results, the study recommends that the government educates the locals on the negative aspects of the age-old traditions and impress upon them to adopt modern techniques of farming to increase economies of scale, conserve environment and sustain the marginal resource.

Keywords: Economies of scale, Kenya, marginal land, sustainable agriculture

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Resilience of South African Grasslands and Savannahs to Degradation

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The high spatial and temporal variability of semi-arid grassland and savanna systems and the related provision of ecosystem services are well recognised. In rangeland systems, vegetation is principally affected by variable environmental conditions (mainly climate and soil) and by livestock management. The extent and interaction of these drivers, however, are not well understood, but have profound impacts on the resilience of these systems, a decrease of which can increase the risk of systems shifts towards unfavourable degraded or bush encroached states.

Within the context of an interdisciplinary research group we aim to analyse and model rangeland vegetation and to assess the impact of management and environmental conditions on the resilience and vulnerability of rangeland systems. Three indicators of resilience are used, (i) the potential of pastures to produce palatable biomass, (ii) the variability of this production, and (iii) the systems' potential to recover from disturbance impact, for which we assess the impacts of management, climate and soil variables.

Our experimental design considers two study sites in South Africa, representing the grassland and the savanna biome respectively. At each site, three land tenure systems are studied, which differ in access regime to pastures, subsistence level, and livestock management strategies.

Measurements are carried out on several farms in each tenure system and include regular biomass harvests, species monitoring, soil analysis and the recording of weather data. In addition, high-resolution remote sensing imagery (RapidEye) is used to extrapolate ecological field data in space and time. These data form the basis for a spatially explicit grassland productivity model, which will assist to achieve a functional understanding of rangeland degradation processes, and to assess the impact of management and climate on rangeland resilience.

In this contribution we present our methodological design and results from the first year of measurements. We will also inform about the larger interdisciplinary and international research project to which our results contribute, which offers diverse opportunities for collaboration and cooperation.

Keywords: Degradation, grassland, rangeland, resilience, savannah, vegetation modelling

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Degraded Land Rehabilitation of Coltan Mining Sites in Western Rwanda with Local Organic Materials

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Little is known about the effectiveness of low-input methods to rehabilitate wastelands from coltan (tantalum) mining in Africa. This study therefore investigated a combination of organic soil amendments to promote the growth of leguminous agro-forestry species on degraded soils of the Gatumba region of Western Rwanda. Three fast-growing leguminous species, *Tephrosia vogelii* Hook., *Leucaena diversifolia* (Schlecht) Bentham and *Cajanus cajan* (L.) Millsp. were grown over four months on three substrate types collected from the local mining sites: a pegmatite dump (S1), a technosol (S2), and a pegmatite dump developing into a gleysol (S3). These substrates were amended 1:1 (w/w) with (i) compost (kitchen refuse plus garden waste, S1/S2/S3+CP), (ii) manure (cattle faeces plus bedding and urine, S1/S2/S3+M) and the equal part combination of compost plus manure (S1/S2/S3+(CP+M)). Manure and compost were applied at 5 t dry matter (DM ha^{-1}). For all species, the growth parameters including survival rates (2 months after sowing; MAS), plant height (4 MAS), shoot dry matter (4 MAS) and root dry matter (RDM; 4 MAS) were determined. Survival rate of T vogelii was highest compared to the other species and varied from 39 % (S1+M) to 56 % (S1+CP+M); 50 % (S2+M and S2+CP; respectively) to 61 % (S2) and from 28 % (S3+CP) to 67 % (S3). Irrespective of soil types and species, substrate amended treatments yielded higher plants than unamended controls. *C. cajan* plants were highest averaging 54.4 cm for S1+CP+M, 60.2 cm for S2+CP+M, and 47.9 cm for S3+M. Although heights of *T. vogelii* were smallest regardless of substrate, its shoot dry matter (29.3 g plant^{-1}) and root dry matter (0.9 g plant^{-1}) was highest on S2 due to the combined effects of CP+M. On S3 manure application promoted the shoot development of all species, but most for *T. vogelii* (21.6 g plant^{-1}) corresponding to a 91 % increase compared to the unamended control. Of the species tested *T. vogelii* seems most suitable for the recultivation of degraded mining soils given its high survival rate. Its development can be substantially enhanced by the application of compost or compost+manure.

Keywords: Agro-forestry species, coltan mine reclamation, compost, manure shoot and root biomass, survival rate

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Developing Away from the Land: Non-farm Economy and Social-ecological Resilience in Southern Morocco

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While globalisation is a threat to marginal environments in some places, it may also be opening up new venues for conservation in others. The last few decades have witnessed a shift in many rural areas around the world from a predominantly agrarian economy towards an economy dominated by remittances and non-farm activities, sometimes associated with a release of pressure on local nature resources. This recent phenomenon has implications for development and environment policies in marginal areas that have not yet been fully comprehended.

The present case study is based on original field data collected in 2009–2010, and aims at understanding social-ecological dynamics in a marginal area of southern Morocco in the context of globalisation. It integrates change detection by remote sensing with a comprehensive retrospective household survey on land use and livelihoods from a series of villages in the argan woodlands of the Suss region.

In the argan woodlands of Southern Morocco, fuelwood sales traditionally acted as a buffer against drought, because wood was the only nature resource available to households in cases of harvest failures. Our data show that fuelwood over-harvesting was partly responsible for an important decline in woodlands density between 1970 and 2007. New labour opportunities in Morocco and abroad have progressively helped to replace this buffer by another, that of wage labour and remittances. The role of local resources in livelihoods has decreased drastically. Livestock numbers have decreased, marginal land has been abandoned, and the number of households selling wood for a living is now close to zero. The reliance on non-farm activities and remittances has shifted the object of vulnerability from climate to markets, as most people now depend on the availability of wage labour, which is not constant. Meanwhile, development and environment policies still focus on nature resource-based livelihoods and resilience to drought, overlooking the new opportunities and threats opened up by this transition to non-farm activities. Our study suggests that supporting and strengthening the shift toward the non-farm economy may do more in some places for development and conservation than improving agricultural productivity.

Keywords: Deforestation, drylands, Morocco, non-farm, policy, remittances

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Impact of Reduced Fallow Availability on Crop Yields in Low Input Cropping Systems in West Africa

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Cropping systems in West Africa are predominantly low-input systems based on invading virgin land and/or soil fertility restoration through fallowing under the natural regrowth of vegetation. In many countries, the use of mineral fertiliser is extremely low with average application rates below 10 kg ha^{-1} cropland. On the other hand, increasing population pressure leads to reduction in fallow availability and compromises soil fertility restoration. In the Republic of Benin, the demographic projections for the first half of this century indicate a continuous growth of the population with a narrow interval of confidence. In the absence of an adequate soil fertility management with judicious use of mineral fertilisers, the soil degradation process with decreasing crop yields is expected to continue. The objective of this paper was, therefore, to quantify the regional effect of future population growth on crop yields in West Africa. Three land use scenarios (L1, L2 and L3) for the Upper Ouémé catchment (15,000 km^2) where derived from different demographic projections combined with assumptions regarding future road networks and legal frameworks for forest protection using the CLUE-S modelling approach. The fallow-cropland ratio decreased in the three scenarios from 0.87 in the year 2000 to 0.66, 0.48 and 0.68 for L1, L2 and L3 respectively in 2050. Based on the projected ratio of fallow and cropland, trends of maize yield for the three land use scenarios were calculated using the EPIC (Environmental Policy Integrated Climate) model coupled with a spatial database. Maize yields followed the decreasing trend of the fallow-cropland ratio and estimated yield reductions amounted to up to 24 % in the period 2021 to 2050. When comparing the yield reductions caused by reduced fallow availability with the impact of climate scenarios in the literature, it can be concluded that, in the near future, land use effects will be at least as important provided that soil fertility management does not change.

Keywords: Crop yield, fallow systems, land use change, West Africa

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Lost Potential: Impact of Land Use Change on Land Productivity in Western Kenya

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Land degradation is recognised as a major threat to the ecosystem functioning both in the areas classified as high and low agricultural potential. Western Kenya is considered a bread basket area of the country. However, the capacity of the region to produce food while at the same time ensuring environmental integrity is seriously threatened. A study was conducted in Malava Division of North Kakamega District to assess the effect of land use change on the productivity of land. The study site is in the transition zone between a natural tropical forest and agricultural land. To facilitate representative sampling and mapping of the entire landscape, the Land Degradation Surveillance Framework (LSDF) developed by African Soil Information System (AfSIS) was applied. A "Blocks", 10×10 km in size was demarcated and divided into 16 clusters. The sampling plots were then randomised around each cluster centre point, resulting in a spatially stratified, randomised sampling design. In addition to the above sampling points, the study identified 15 'undisturbed' reference sites to be sampled and used as baseline for land use change assessments. From each sampling point, representative soil samples were collected and bulked for analysis. The surveys revealed that production of the main cereal maize was low, averaging less than $1\,t\,ha^{-1}$. Majority of farmers were shifting towards cash crop (sugarcane) production. The main drivers of land use change in the region are agriculture and soil erosion, followed by tree cutting, fuelwood collection and grazing. Preliminary results show that over 60 % of the land was experiencing some form of soil erosion. There was a strong correlation between tree cutting, grazing and fuel wood collection on soil erosion. Laboratory analysis showed that most soils in the region were highly acidic (pH$<$ 5.5) and deficient in most major and micro-nutrients. As a result of the low production on these acid soils, there was more pressure to convert the natural forest to agricultural land. Holistic strategies are needed to address the drivers of land degradation in the region mainly declining soil fertility, soil acidity, increased soil erosion, deforestation and fuelwood scarcity.

Keywords: Land degradation, land use change, soil acidity, soil fertility

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Assessment of Decision Making in Grazing Management: The Case of Gabra Pastoralists of Northern Kenya

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Livestock in pastoral production systems in northern Kenya depends fully on forage from pasture areas. These pasture areas are under communal use and are characterised by high spatial variability with regard to bio-physical characteristics. High temporal and spatial variability of rainfall contributes to a pronounced patchiness of the available fodder resources. In this situation the amount of feed livestock can intake depends on the decisions of the pastoralists which grazing unit to use at which time. The main aim of the study was therefore to identify grazing quality indicators and factors considered by Gabra pastoralists in selecting grazing units in Chalbi District of Marsabit County. Data collection involved following steps: a) Participatory resource mapping in three different sublocations, pastoralists completed a map indicating grazing units used for grazing of goats; b) seasonal calendars were used to retrospectively document the grazing itinerary of 30 goat herds; c) real time herder-based ecological monitoring using solar based GPS data loggers were tried out with 3 pilot herders. This was accompanied by own monitoring of selected areas using pastoral rangeland scouts. The preliminary results of the study indicated; the classes of Gabra land utilised for goat grazing including Acacia woodland, stony land, and clan-based land classes. The general characteristics of suitable grazing areas identified were; shade, white soils, small stones (70 % land cover), and key pasture species like Tribulus terrestis. Additional factors considered by Gabra pastoralists in selecting favourable grazing units were availability of labour, sorio (prayer) months and traditional wedding ceremony seasons. The grazing management of Gabra pastoralists involves both daily movement and year round grazing itineraries. The daily herding movement changes grazing site within same grazing unit. The year round grazing itinerary involves the movement of herd from one grazing unit to another. The results show that the decisions about the grazing units of Gabra pastoralists are influenced both by grazing quality indicators and factors related to the social life.

Keywords: Grazing management, indicators, pastoralists

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Spatiotemporal Dimensions of Vegetation Dynamic and its Relationship to Human Activities in the semi-Arid Zone of White Nile State, Sudan

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Vegetation cover is one of the most important components of ecosystems, particularly of the dry zones (vulnerable land). This cover is always in a dynamic status throughout time and throughout place, and in the vulnerable zones particularly. It is responsible for the equilibrium of the environment, therefore it needs accurate monitoring and assessing of its dynamic and its relation to human activities such as the land use practices.

The study carried out aimed to map, to monitor, and to analyse the status (rate and trend) of the vegetation dynamics, and its relationship to human activities (different land use patterns) through spatial and temporal dimensionality in a semi-arid zone of the White Nile State (El Geteina area), Sudan. The synergism approach of remote sensing, ground truth and socio-economic data was mainly utilised for achieving the study objectives. Whereas the vegetation indices (NDVI and SAVI), hybrid classification approach-Mahalanobis distance classifier, and post classification (change detection and matrix) was done to analyse the satellite data images of MSS 1973, TM 1986, and ASTER 2009 (for 36 year). Through the analysis, the pre-processing and processing of data images fusing with ancillary data was done, to derive information using ERDAS IMAGINE and arcGIS.

The results depicted that the vegetation cover increased 0.093 km^2 estimated with 0.007 km^2 annually between 1973 and 1986, and it decreased 22.911 km^2 estimated with 1.761 km^2 annually between 1986 and 2009. It was also found that 3.19 km^2 of the vegetation cover converted into agricultural land and at the same time 9.54 km^2 of agricultural land converted into natural vegetation between 1973 and 1986, and 3.96 km^2 of the vegetation converted to agricultural land and 1.35 km^2 of the agricultural land converted into natural vegetation cover. So the results illustrate that a relationship between the vegetation dynamic and the human activities was obviously.

Keywords: Human activities, remote sensing, vegetation, White Nile State

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Climate change

Climate Dynamics and Agricultural Development

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Agricultural land-use is a key driver for the development of marginal lands and rural societies. At the same time, the expansion of agricultural land and the intensification of production systems increase many land-use related conflicts (*e.g.* ecosystem decline, land tenures and access to water).
Strategies to alleviate hunger and poverty have to consider potential future developments that could change regional needs and/or the foundations of project plannings. In this regard, climate change could have a high impact on land-use and land-cover change. However, their projections are uncertain with high variability among different state of the art climate models. Nonetheless, the high relevance to land-use change together with high uncertainties outline the need for climate impacts studies on agricultural systems.
Recent studies on future climate change impacts on agriculture production emphasised on mean climate change patterns. Vulnerabilities to annual climate fluctuations have rarely been considered. Although they bear high potential risks to prevent marginal land to develop.
We assume that climate change impacts are underestimated when relying only upon analysis of mean climate changes. For that reason, our study focuses on yield fluctuations due to climate dynamics. We use the dynamic vegetation model LPJmL to model yield developments on a grid level and compare aggregated annual mean values with FAO statistics from 1970–2000. We than change the models climate input and analyse how climate change could impact yield fluctuation and agricultural production systems in the future. We obtain potential agricultural sensitivities to climate extremes from the grid cell level to the country scale and identify regions, most prone to climate and yield fluctuations.
Because rural incomes in tropical and sub-tropical regions are highly related to agriculture, studies on yield fluctuations do not only encompass food production, but also food access and food stability. In this regard, the study results can contribute to help establishing long lasting and cost efficient food security projects that reduce hunger and increase income among marginal people.

Keywords: Climate extremes, food security, land use, yield fluctuation

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Shaping Agricultural Innovation Systems Responsive to Food Insecurity and Climate Change

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Climate change and variability present new challenges for agriculture, particularly for smallholder farmers who continue to be the mainstay of food production in developing countries. Global food crises of recent years have exposed the structural vulnerability of increasingly globalised agri-food systems. In this context, climate change is one of a complex of environmental, demographic, social and economic drivers generating unprecedented levels of instability and food insecurity, the impacts of which disproportionately effect poorer groups in marginal environments. Rather than search for single causes, we argue, there is a need to understand these changes at a systemic level. Improved understanding of and engagement with the adaptive strategies and innovations of communities living in conditions of rapid change provides an appropriate starting point for those seeking to shape agricultural innovation systems responsive to food insecurity and climate change.

This paper draws lessons from selected country experiences of adaptation and innovation in pursuit of food security goals. It presents three case studies of systems of innovation operating in contrasting socio-economic, geographical and agro-ecological contexts and facing different challenges. In Southeast Asian post-Green Revolution rice cultivation we trace innovations responding to unintended consequences of rapid technological change. In India we focus on attempts to recover degraded semi-arid lands and livelihoods bypassed by the Green Revolution in a rapidly developing now middle income economy and a functioning democracy; in southern Africa we explore responses to similar social and environmental challenges to those in the Indian context, but in low income economies with less developed institutions and democratic practice. We review each case in terms of four features of innovation systems more likely to build, sustain or enhance food security in situations of rapid change: (a) recognition of the multifunctionality of agriculture and opportunities to realise multiple benefits; (b) access to diversity as the basis for flexibility and resilience; (c) concern for enhancing capacity of decision makers at all levels; and (d) continuity of effort aimed at securing well-being for those who depend on agriculture. Finally we draw implications for policy makers and other stakeholders in agricultural innovation systems.

Keywords: Agricultural innovation systems, climate change, food security

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Resilience and Vulnerability in the Face of Potential Climate Change: The Case of Sudan

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The present study was undertaken generally for the purpose of assessing the changes and causes of vegetation cover from 1984 to 2010 in a sample unit covering parts of Renk County in southern Sudan. Normalized difference vegetation index (NDVI) was used to analyse the remote sensing images to indicate the trend of vegetation cover changes over time and space. Results indicate a strong positive correlation relationship of NDVI with rainfall in southern Sudan occurring in 1994, 2002, 2005 and 2010 in large area of Renk County that has been colonized by green vegetation. The main cause of the increased vegetation expansion or probably the rate of woodland encroachment in grassland savannah zone has been attributed to a variety of factors such as: Availability of moisture (*e.g.* irrigation), changes in rainfall patterns and minimum or no human impact, particularly during the north-Southern war. Results also indicate that Renk County adopts an integrated approach in addressing key drivers of vulnerability which include socio-economic aspects of the impacts of potential climate change. The successful experience of forests and trees thus far has been recognised by local communities as a significant contributor to building resilience against external shocks due to the risky environment and also due to the intra-seasonal and inter-annual variability of rainfall. The study demonstrates that forests contribute to rural development; help to reduce the vulnerability of communities and allow the rural poor to survive through recurrent hungry seasons. The study suggests that specific plans for adaptation to climate change need to be incorporated into wider regional and national development planning.

Keywords: Climate change, marginal land, marginal people, resilience, resource management, Sudan, vulnerability.

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Beyond Climate Change Mitigation: Can Trees Buffer Moderate Temperature Increases on Croplands?

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Traditionally, trees are considered a means of climate change mitigation through sequestering CO_2 in their biomass. Recently, awareness increased of large forest complexes having significant impact on micro- and mesoclimate, counteracting adverse climate change effects. Less evidence exists on the effects of smaller groups or even single trees that define agroforestry practices in the tropics.

There is general agreement in the projections of GCMs that many marginal regions in sub-Saharan Africa will experience substantial increases in temperature and hence evapotranspiration in the coming decades. Such additional warming will put traditional crops and cropping systems at risk. We hypothesise that the presence of trees in agricultural landscapes can create a microclimate that buffers moderate temperature increases from climate change. Instead of immediately replacing a traditional crop, the inclusion of trees may hence provide a considerable step towards the resilience of marginal agriculture to climate change.

We present first results of a study carried out in a vulnerable region of Tanzania in the transition zone between bimodal and unimodal rainfall regimes. Automatically recording weather stations were placed 50 m apart in an open maize and sorghum trial field and in an identical field under partial cover of *Acacia polyacantha* Willd. for 2 years equal to 4 cropping seasons. The continuous hourly data of air and soil temperature were compared from both stations. The overall trend showed that in reference to a regionally downscaled IPCC A1B scenario at high spatial and temporal resolution, temperatures in the agroforestry site trailed the ones on the open crop field by about 20 years.

We conclude that warranting repetitive validation at different scales and consideration of interception losses through trees, this study clearly indicates that trees can fulfil a second role in mitigating adverse temperatures and climate change in marginal lands. Including trees into farming systems can build resilience and buy sufficient time for farmers to familiarize with potentially harsher climate impacts.

Keywords: Agroforestry, climate change, cropping systems, Tanzania, temperature buffering

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Sustainable Land Management and Resilience to Climate Change in Tajikistan

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In Tajikistan, the increasing pressure on available land combined with inappropriate land use practices has led to widespread unsustainable land management. As a consequence, rural livelihoods that support the majority of the population are being negatively affected by land degradation such as fertility decline due to soil nutrient mining, soil erosion due to bad vegetation cover management, and inadequate forest management due to demands for fuel and timber. For the coming years, it is expected that Tajik agriculture faces varying climate change impacts which, on the whole, will further deteriorate production conditions and thus adversely affect the economy and rural livelihoods. With the existing land degradation impacts noted above, sustainable land management (SLM) strategies and practices become even more critical for Tajikistan. SLM can enable land users to adapt, as well as become more resilient, to climate change by conserving soil and water, restoring productive natural resources, enhancing food security and increasing food production. In order to develop strategies for climate resilient adaptation of land management, knowledge is needed on the state of land resources in Tajikistan today and on SLM opportunities for climate change adaptation. Therefore, an inventory of relevant past and current projects/initiatives in SLM was prepared using the WOCAT (World Overview of Conservation Approaches and Technologies) framework. Case studies on SLM technologies as well as SLM approaches covering all major land use types in Tajikistan were documented through interviews with land users and SLM specialists. The case studies were then assessed for their climate resilience applying the newly developed WOCAT climate change module. In order to test the documented SLM technologies and approaches for their applicability, workshops were organised with rural communities in the different agricultural zones of Tajikistan. Experienced and anticipated climate change impacts on the communities were discussed and land users selected and assessed those SLM practices they regarded the most suitable ones for climate change adaptation in their context. The goal of this study was to identify best SLM technologies and approaches to improve rural livelihoods and resilience to climate change and to make recommendations for their up-scaling.

Keywords: Adaptation, climate change, land degradation, resilience, rural livelihoods, sustainable land management

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Identification of Agro-pastoralist Adaptation Strategies to Climate Variability: A Case Study in Mopti-Mali

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The climate of the West-African Sahel has changed significantly during the past decades, and climate models showed an increase variation in the amount and periods of precipitation, and an increase in temperature. Agro-pastoralists in drylands of Mopti are affected by increasing climate variability due to high reliance on rainfed agriculture, a climatic sensitive sector. The objective of this study is to identify changes observed by agro-pastoralists, and which strategies they use to adapt to the changes. Ten villages were used in this study, two host villages and eight neighbouring villages. Two weeks was the stay in each host village, and eight neighbouring villages visited on daily basis, using a motorbike. Data collection was qualitative, with a combination of the following methods: key informants interviews, individual and group interviews, workshops and participants observation. Interviews were translated from Fulani to French, recorded and further transcribed for content analysis.
Climatic changes observed by agro-pastoralists are: insufficient rainfall, unreliable precipitation, increase in wind speed and temperature. Regarding crop farming, observed changes alter the period of farm activities, with impacts on crop yields. Regarding livestock keeping, such changes impacts feed availability, growth and calving interval in cattle. The results of this study show that, agro-pastoralists in Mopti adopted a series of measures, with the aim to ensure harvest and livestock productivity. However, most adaption measures identified occurred within the livestock sector. Such strategies include alternative feed sources for the livestock kept in the vicinity of the villages, for example by using wild fruits such as: balanzan (*Acacia albida*), barkehi (*Piliostigma thonningii*) and kohic (*Prosopis africana*) to sustain livestock through the long dry season. Due to fodder scarcity, crop residues are important sources of livestock feed during the dry season period, hence livestock keepers seek storage techniques that preserve the quality of stored residues for a longer period of time. Autonomous adaptation is incessant in the agro-pastoral systems of Mopti; however, the magnitude and speed of climatic changes might increase and since its impact is intertwined with effects of population growth and reduction of agricultural land, agro-pastoralists innovative capacity might lack behind the occurring changes.

Keywords: Adaptation strategies, agro-pastoralists, climate variability

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Climate Change and Uncertainty in Local Agriculture in Kenya: Do Farmers Have Options?

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Climate change sets an unprecedented challenge for humanity in the 21 st century. Communities in developing countries will be the most vulnerable as they have the weakest adaptive capacity to cope with this change, including farmers in Kenya. Much scientific work on climate change has focused on the global and regional levels, with little emphasis on the local context, yet, climate change impacts will be most felt at the local levels; specifically for small-scale agriculture, which forms the base for most livelihoods in Kenya. If sustainable agricultural development is to be realised in Kenya, climate change responses need to be harmonised with national development strategies. This paper highlights climate change induced challenges of smallholder agriculture and presents options and opportunities to deal with drier climates as seen by farmers. It spotlights the plight of smallholder farmers in Laikipia District, Kenya, and their deteriorating agricultural production under current experiences of climate variability and change. Data was collected between October 2010 to May 2011. Qualitative data includes results from 20 focus group discussions and 34 key informant discussions with male and female farmers. Quantitative data comprised results from 200 questionnaires. Qualitative data was analysed using Atlas-ti, quantitative data was analysed using SPSS software. Results indicate smallholders identify with climate variability and change in form of reduced rains, increasing temperatures, increasing prevalence of animal and crop diseases and change in wind directions. Smallholder agricultural activities depict uncertainty manifested in planting diverse crops' varieties in seasons to reduce risks of crop failure. These results provide a platform for discussing farmers' plight in the wake of a changing and challenging climate. The results are important to decision and policy makers in agriculture to develop and improve agricultural support measures for smallholders in Kenya.

Keywords: Agriculture, climate change, options, smallholders, uncertainty

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WASCAL - The West African Science Service Center on Climate Change and Adapted Land Use

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West Africa is one of the most vulnerable regions to climate change. The high dependence on natural resources and the agricultural sector for incomes and livelihoods, inadequate economic and technological development, inappropriate services and poor infrastructure, weak governance and institutions, rapid population growth, as well as growing poverty and food insecurity result in limited adaptation capacity of the region to climate change and increasing climate variability. Furthermore, the uncertainties surrounding climate change projections, particularly the changes in spatio-temporal patterns of rainfall, hamper the design and implementation of adaptation measures. To meet these challenges, West African and German scientists have developed the concept of the "West African Science Service Center on Climate Change and Adapted Land Use (WASCAL)". WASCAL is an initiative of the German Federal Ministry of Education and Research (BMBF) to establish a centre of competence on climate change and adapted land use in West Africa (currently, the countries involved are: Benin, Burkina Faso, Côte d'Ivoire, Gambia, Ghana, Mali, Niger, Nigeria, Senegal, Togo). The centre will help generate the knowledge and develop the analytical capability in the region to solve current and future land management problems caused by changing climate and weather conditions. The overall aim is to identify resilient land management approaches and develop measures to conserve or restore functional ecosystems that support sustainable human development, while preserving the natural resource base for future generations. WASCAL's principle components are the competence centre, a core research programme and graduate research programs. The concept of WASCAL and its current state of planning will be presented.

Keywords: Adaptation to climate change, competence centre, graduate school, research program

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Comparison of Spatial Interpolation Methods for Filling Daily Rainfall Missing Data, Blue Nile Basin, Ethiopia

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Hydrological modelling and water resources development project designs need sophisticated procedures that require continuous meteorological data for better water resource management. Rainfall is one of these important meteorological variables that determine water availability and the hydrological processes in the hydrosphere. In addition, rainfall is more variable with in short distance in space than other meteorological variables. However, input data from most of the meteorological stations are missing and there is shortage of long-term continuous database in important watersheds of developing countries like the Blue Nile River Basin in Ethiopia, where water resource developments have been practised at large. Four methods (arithmetic mean (AM), normal ratio (NR), inverse distance weighting (IDW) and coefficient of correlation weighting (CCW)) were compared to estimate daily rainfall data around *Gumara* watershed in the Upper Blue Nile basin. Daily rainfall data of nine meteorological stations from 1987 to 2008 was used for this study. The result shows that AM and CCW gave promising estimation for missing daily rainfall data of the study area and thus it enhances better understanding and decision making. Arithmetic mean method gave better daily rainfall estimates for meteorological stations found on the lowland plain and around the Lake Tana shore while CCW estimated better for stations found on the upstream steep and mountainous area as compared to IDW and NR. Normal Ratio is not a good estimating method for the area at all. Meteorological stations with high number of missing data, that were not considered before, can use near-by stations that have a better data availability by using AM and CCW methods for water management activities of the area.

Keywords: AM, Blue Nile basin, CCW, missing data, rainfall

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Climate Change-related Vulnerabilities and Adaptive Capacities of Populations in Marginal Areas of Central Asia

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Central Asia is located in arid and semi-arid regions with significant areas affected by anthropogenic and natural land degradation. Agriculture is the leading economic sector and a key source of livelihoods in most of those marginal areas. The marginal areas in Central Asia are also prone to significant weather volatility. Climate change is projected to further exacerbate the weather volatility with a potential to increase the vulnerability of local agricultural populations to annual and seasonal weather fluctuations and extreme events. Therefore, it is important to i) identify the extent of vulnerability of agricultural production in marginal areas to current weather fluctuations and anticipate possible impacts of increased weather volatility in future, ii) estimate the potential interactive effects of weather volatility and land degradation on agriculture, and iii) identify factors leading to stronger resilience and adaptive capacities of agricultural producers in marginal areas. To answer these questions, we use a random-effects panel model at the province level (1991–2009) for the five countries of Central Asia – Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. We hypothesise that agricultural production in marginal areas of the region is negatively impacted by climate change; coupled with land degradation, this impact is likely to be magnified. Given their unfavourable natural endowments and weak response behaviour, we expect that people in the marginal areas are least prepared for the effects of climate change and extreme events. Therefore, targeted development interventions are needed to increase their adaptive capacities which would include investments in marginal-area specific agricultural research (for example, salinity and drought-resistant crop cultivars), better infrastructure, higher access to credit and extension.

Keywords: Central Asia, climate change, land degradation, marginal areas

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Estimating the Impact of Climate Change on Maize Yield and Planting Dates in Southern Brazil

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Global warming and climate change are evident and widely accepted, while implications and extent of these factors are still in discussion. Climate is the most important input of agroecosystems, usually determining crop success or failure. For some regions of the world climate change will be manifested by increase in temperature and precipitation, although other will experience rainfall reduction. The aim of this work is to use a decision support system called SUR–INTA to estimate the impact of climate changes on maize production in Não-Me-Toque region, southern Brazil, within different planting dates (starting on August 2nd and every subsequent month until December 2nd, performing five planting dates). Using actual and past weather data (50 years), soil and crop responses to environmental factors, simulations were run to assess the performance of the decision support system. Once simulated values were compatible with observed crop data, synthetic series of weather with modifications suggested by several climate scenarios were run. For the study region, the same weather data had the minimum temperature increased by 0.3°C uniformly all over the years, and the precipitation increased by 10 % at each event. Even though it is impossible to predict if changes will occur uniformly, or in one season, this simulation is important to show the impacts of climate change on crops. As preliminary results, the mean maize yield was slightly higher in the future scenario due to an increase of water availability. Planting dates showed significant differences: under actual conditions the earliest planting dates pose a high risk of frost, potentially destroying the crop, with the best planting dates between October and December; for the future scenario, the best planting date was August, probably because of the reduction of frost risk and also due to better use of water, since atmospheric demand for water is not so high as in later planting dates. Very important information is that maize will have a shorter growing season due the increase of temperature, which leads to faster accumulation of degrees day and premature end of phenological stages. Although the crop reaches maturity faster, it will have less time to accumulate biomass or fill grains.

Keywords: Climate change adaptation, decision support systems, future scenarios

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Analysing Land Use History in the Northern Rift Valley Lake Basins of Ethiopia to Identify and Assess Local Coping Strategies to Maintain Food Security under Imminent Climate Change

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Ethiopia as many other developing countries faces currently environmental problems such as land degradation and loss of forest. The country has also experienced frequent drought resulting from climate variability. These problems have impacted on the food security of the country. At the same time, coping strategies are developed by local farmers, which include land use change towards more stress-resistant crops and management practices that reduce or evade drought stress. Identifying and distributing successful coping strategies requires monitoring of resources and practices, which should be based on reliable information. The current land use information situation in the country can be characterised as weak and needs improvement. The objectives of this study include investigating experiences in implementation, designing and implementing of a Land Use Information System (LUIS) that can effectively and efficiently support the analysis of current land-use practices; analysing the land-use history and change in context with the onset and duration of seasons; identifying farmers' adaptation strategies to climate variability; and evaluating the land-use potentials for environmental services. The research is undertaken in the Northern Part of the Rift Valley Lake Basins of Ethiopia. A geodatabase is designed to support the use of different data from various sources including remote sensing, ground surveying, participatory GIS and existing data. The framework is implemented based on open source Geographic Information Systems (GIS) including Quantum GIS, Geographic Resources Analysis Support System (GRASS GIS) and PostgreSQL (with PostGIS spatial extension). Expected outputs of the research include guiding principles for LUIS development with emphasis on agricultural applications; as well as models to support land use planning and monitoring at local level. These include development of a methodology which integrates various data from different sources for analysis of land use history in the context with onset and length of growing seasons; understanding of farmers' adaptation strategies to climate variability to ensure food security; and analysis models for evaluating the land-use potentials for environmental services taking C sequestration as a case study. The poster presentation will show the integration of different data sources in the information framework and demonstrate how selected datasets are represented in the LUIS.

Keywords: Climate variability, GIS, land use history, local coping strategy, remote sensing

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Assessing Best Agricultural Practices to Improve Future Climate Change Adaptation of Agro-landscapes in Tanzania

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Scenarios derived from Global Change Models for Emission Scenarios (SRES) indicate temperature rise and water scarcity in most parts of East Africa. Within Tanzania's National Adaptation Programme of Action (NAPA) it was estimated that the mean daily temperature will rise by 3–5°C and mean annual temperature by 2–4°C throughout the country. The predictability of rainfall events and amounts will decrease considerably. The adaptive management of rural communities has to be strengthened and strategies to improve the resilience of their agro-landscapes are needed. It is not yet sufficiently analysed how to downscale the effects of global and regional climate change scenarios to village level. This case study, conducted within the project Resilient Agro-landscapes to Climate Change in Tanzania (ReACCT), presents a scenario-based approach how to select best agricultural practices for local climate change adaptation. Two villages with contrasting agro-ecological and socio-economical frame conditions were selected in the Ngerengere catchment basin in the Morogoro district and factors for future land use scenarios identified and streamlined in a causal chain. Information of past and current trends of these factors was gathered through individual household surveys, focus group discussions and secondary research. Future climate scenarios were obtained from PIK's CCLM (Cosmo)-models and aligned with local stakeholders' perceptions about climate change. Based on frame conditions and assumed changes in drivers of agro-landscapes, baseline scenarios for the year 2030 were created for each village together with local stakeholders. We present how impacts of selected best agricultural practices on local pressures were appraised through including them into the baseline scenarios. In that way it is possible to give explicit recommendations to decrease the local vulnerability of agro-landscapes against negative climate change impacts and to increase food security.

Keywords: Agro-landscape, climate change adaptation, East Africa, land use change, participatory methods, scenario development

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Climate Change Impacts, Coping Strategies, and Adaptation Practices in East Africa: A Comparative Analysis of Ethiopia and Kenya

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Climate change has become a highly prominent topic in the 21*st* century with its impacts, adaptation and coping mechanisms being examined in numerous recent studies. The current prominence of this subject among researchers and decision-makers is justified by its far-reaching social, political, environmental, and economic consequences on rural households who depend largely on rainfall for farming activities. This paper examines the impact of extreme climatic events on farm households in Ethiopia and Kenya based on a review of recent empirical studies in these countries. The conceptual framework used for the analysis differentiates the socio-economic implications of climate change into (1) impacts on livestock and crop production systems, (2) ex-ante adaptation and ex-post coping strategies, and (3) household resilience. The study was based on a review of climate change publications, expert interviews, and key informant discussions. Secondary data from recent studies based on a sample size of about 1200 farm households from each country were analysed to examine the coping strategies and adaptive capacity of households. The main coping strategies identified are the sale of productive and household assets. Some households reduced the quantity and frequency of food consumption or borrowed money from informal credit sources, such as relatives and friends, for consumption smoothing. Planting of early yielding trees, soil moisture conservation, and investments in shallow wells for watering livestock and irrigating crops were some of the common adaptation practices employed by farm households in Ethiopia and Kenya. However, there is evidence that farmers in Kenya are better adapted to climate change than farmers in Ethiopia. Some identified reasons for the relatively low degree of adaptation in Ethiopia are lack of information, inadequate access to credit, and lack of technical knowledge. We recommend an integrated approach consisting of proactive Government interventions to formulate policies that will create social networks to support farm households. Better credit access to farmers will facilitate private investments in irrigation systems. Crop and livestock insurance should be used as an alternative means of supporting the poor. Seasonal weather forecasts should be made accessible to farmers to increase awareness of future weather conditions for effective planning.

Keywords: Adaptation practices, climate change, coping strategies, impacts

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Climate Signals in Multiple Tree-ring Proxies (ring width, δ^{13}C and δ^{18}O) from Tropical Trees: An Example on *Tectona grandis* from Indonesia

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Extreme climate events have profound socio-economic impacts on human population across the tropics. Climate in Indonesia is mainly dominated by the equatorial monsoon system and tends to be linked to El Niño-Southern Oscillation (ENSO) events which results often in extensive droughts and floods over the Indonesian archipelago with devasting effects on the population. Hence, high-resolution proxy climate records (*e.g.* tree-ring records) can improve our understanding and prediction of such events, but are extremely scarce in the tropics. This study presents tree-ring width and stable isotope (δ^{13}C and δ^{18}O) records developed from Indonesian teak (*Tectona grandis*). This species is one of the few showing annual growths boundaries allowing to establish precisely dated chronologies to reconstruct climatic or environmental changes. Ring width chronologies from Indonesian teak have frequently been used for climatic reconstructions. However, the influence of other climatic or environmental parameters on Indonesian teak has not been studied yet. For testing the relevance of changes in temperature and precipitation dynamics we follow a multi-parameter approach using tree-ring width and stable isotopic composition in tree rings. To this end, tree cores of *T. grandis* were developed into a more than 200-year long tree-ring widths chronology and 100-year long δ^{13}C and δ^{18}O records, whereas the latter one are the first long-term stable isotope records from this region. Relations between tree-ring (tree-ring width, stable isotopes) and meteorological data demonstrate that the tree growth is mostly influenced by the seasonal precipitation. First results of highly resolved intra-annual δ^{18}O studies will be presented, which may provide more detailed insights into the influence of seasonally changing precipitation amounts on stable oxygen isotope distribution in tree rings and related tree growth. This may improve land-based rainfall reconstructions based in multiple tree-ring parameters.

Keywords: Climate variability, Indonesia, stable carbon and oxygen isotopes, *Tectona grandis*, tropical dendrochronology, tropics

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Changing Life with Climate: Adaptation through Agro-biodiversity Management – A Case from Nepal

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The third assessment report of the Intergovernmental Panel on Climate Change (IPCC) has identified climate change as a serious threat to agro-biodiversity through alterations in species composition, cropping pattern and productivity. The changing climate is projected to result in remarkable shifts in rural communities' livelihoods causing irreversible damage to their agriculture, forest and other natural resources. This situation demands for potential adaptation strategies to moderate and cope with the vulnerabilities to which the resources and the communities are exposed.

As agro-biodiversity resources are highly sensitive to climate change and the local farmers are in the forefront of the impacts, it is imperative to understand their perceptions on climatic variability and explore their adaptation strategies through agro-biodiversity management against changing climate. This study, based on a case from Pokharekhola watershed in the central middle-hills of Nepal, was conducted in 2009. The primary data were gathered through interviews, group discussions and field observations. Meteorological data and allied study reports were used as secondary information.

The farmers' perceptions on climatic variations like their observation on rising annual temperature, decreasing post-monsoon rainfall, warmer and shortened winters were corroborating with the meteorological data of last two decades. The alteration in tree phonologies and early fruiting and ripening of agro and horticulture crops were the distinctive signs of climate change at local level. Drying of water sources and decreased soil moisture, increased agricultural pests and diseases, and appearance of invasive weeds were observed as immediate climate change impacts. Furthermore, reduced cereal, vegetable and fruit production due to erratic rainfall patterns had the major impact on the people's livelihoods.

The farmers have started adopting some new farming strategies to cope with climate change scenarios at local level such as adjusting the crop cultivation time and supplying irrigation to adapt to the prolonged droughts, using improved seed varieties, replacing cereals with vegetable farming, crop diversification through mixed-cropping, more fodder tree plantation in homesteads, and increased goat raising instead of cattle. These practices of agro-biodiversity management have helped the rural communities to adapt with the adverse impacts of climate change by transforming their life and farming patterns.

Keywords: Adaptation, agro-biodiversity, climate change

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Food Security in the Light of Climate Change and Bioenergy – Potentials to Stabilise Livelihoods for small-Scale Farming in Tanzania

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During the past decades, Climate Change (CC) increasingly challenges research in manifold scientific disciplines. Evidence on the need for better adaptation strategies to CC caused growing efforts to tackles the new challenges in agriculture sciences. Ensuring threatened food security results in a key policy issue, which is even more considerable, when linked with issues on increased bioenergy demand. CC related to energy demands should be seen as a holistic system, which interrelations seek for new strategies focusing especially rural poor in small-scale agriculture. New in-depth methods on feasibilities, sustainable development and economic viability in mixed rainfed crop-livestock agriculture pose therefore a major future challenge.
Three GIZ-financed projects, coordinated by the International Food and Policy Research Institute (IFPRI) and the Leibniz-Centre for Agricultural Landscape Research (ZALF e.V.), enhanced the development of strategies related to CC adaptation and the use of bioenergy in Tanzania. The results of the three projects over a period of four years of intensive research are summarised in this presentation. All partners initiated diverse research activities in the frame of Impact Analysis, which are assembled to one integrated, interdisciplinary research overview to seek for new strategies at the science-policy interface.
The widespread application of these adaptation strategies and practices resulted in methods to design resilient “agro-landscapes” and livelihood systems with improved adaptive capacity to climate change and biofuel value chain management in the fields of energy, transport and agriculture in Tanzania.

Keywords: Agricultural systems, food security, household survey, livelihood

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Quantifying Current and Future Climatic Risks to Cereal Production in Ethiopia as a Basis for Informing Adaptation

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Agricultural development is key to reducing severe hunger and poverty and contributing to environmental sustainability (Millennium Development Goals 1 and 7) in Africa. Agricultural systems will face increasing challenges to meet the growing food demand with less water and less land resources. Climate change is expected to put additional stress on the systems. The extent of hazardous impacts of change will depend on the resilience and adaptive capacity of agriculture, which are determined by natural and socio-economic conditions and differ depending on the region and country.

Ethiopia's agriculture, on which the majority of the population depends, is already seriously constrained by current climatic variability. Despite growing efforts to reduce greenhouse gas emissions, likely impacts of climate change, such as more frequent and more intense droughts and floods put adaptation strategies high on the policy and research agendas. Important questions include: (1) What are the climate induced risks and opportunities for agriculture in vulnerable regions and (2) What are the resilience trajectories of different farming systems under climate variability, climate change and other global changes?

The Finnish-Ethiopian-Dutch collaborative research project AlterCLIMA aims to (i) develop a methodology for addressing these questions, (ii) identify and evaluate alternative adaptation options, the potential of mitigation options and their integration into rural development strategies for selected regions, and (iii) build capacity at Ethiopian and Finnish research institutions to apply the scientific-technical methodology and knowledge base. The project focuses on two contrasting case studies namely, the Central Rift Valley (CRV) with good access to markets, and the remote and highly populated North Wollo district.

In this paper, we present methods, tools and some results of the agroclimatic risk analysis for current and alternative future conditions as a basis for assessing adaptation and mitigation options in the CRV.

Keywords: Adaptation, climate change, climate variability, mitigation

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The Potential of Latin American Coffee Production Systems to Mitigate Climate Change

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A carbon footprint is used to define the amount of greenhouse gas (GHG) emissions emitted along supply chains and is the first step towards reducing GHG emissions. Carbon footprint standards have emerged as new market requirements for producers of agri-food products to retailers in developed countries and are likely to become a comparative advantage. In the coffee sector specifically little literature and data on the carbon footprints of different coffee production systems and supply chains exists. Therefore GHG data from different coffee production systems have been compiled for this study and compared regarding on-farm carbon stocks and the carbon footprint.

To quantify the on-farm carbon stocks and carbon footprints a GHG quantification model; the Cool Farm Tool (CFT) has been used. The CFT uses the Tier II methodology of the Intergovernmental Panel on Climate Change (IPCC) and is based on empirical GHG quantification models build from hundreds of peer-reviewed studies. Field data have been collected in five countries across Latin America from the following coffee production systems: (i) traditional polycultures, (ii) commercial polycultures, (iii) shaded monocultures, and (iv) unshaded monocultures.

The results show low mean carbon footprints of coffee produced in traditional polycultures (3.7 kg CO_2-e kg^{-1}) and commercial polycultures (3.9 kg CO_2-e kg^{-1}) versus high mean carbon footprints at shaded monocultures (9.2 kg CO_2-e kg^{-1}) and unshaded monocultures (9.4 kg CO_2-e kg^{-1}). The same trend is observed concerning on-farm carbon stocks; polycultures (70.9 t C ha^{-1}) versus monocultures (17.8 t C ha^{-1}). Based on the results a framework for site-specific mitigation has been developed to assist coffee farmers in defining climate friendly farm practices and accelerate climate change mitigation in Latin American coffee production.

Keywords: Carbon footprint, climate change, *Coffea arabica*, Coffee eco-system conservation, cool farm tool, Latin America, site-specific mitigation

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Mitigation of Global Climate Change and Water Scarcity Impacts on Agriculture in Draâ Oases, South East Morocco: Methodological Framework

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Since 1979, Morocco has experienced a number of extremely dry winter seasons. Anticipated local and global climatic changes will make the water even scarcer. In the Draâ Oases in South-East Morocco rainfall is almost negligible. The agriculture depends on precipitation and snow melting collected behind Mansur Eddahbi Dam. Erratic changes in rain fall in the dam catchment had sever impacts on downstream irrigated agriculture. Crop management options have been seen as possible mitigation measures. The aim is to increase water use efficiency (WUE) of the areas' main crop and stable food, soft wheat (*Triticum aestivum*). A modelling framework is adopted to test crop management efficacy. The approach is based on two scales: field and oasis. At the field scale, irrigation timing and quantity, different rates of inorganic fertiliser, and organic fertiliser were experimentally tested. Experiments were conducted at two sites, Agdez and Tagounite, in two different oases, Mezguita and Ktoua respectively. Later on, the outcome of these experiments will be used to calibrate EPIC model parameters for the middle Draâ Oases conditions. The calibrated model will be used at the oasis scale, adding soil and climate variability in addition to current and recommended crop management. Different timing for surface water release for irrigation from the Mansour Eddhabi Dam will be modeled as well. Oasis scale modelling results will be validated against own surveyed wheat grain yield statistics for years 2009 and 2010. Two IPCC based climate scenarios downscaled to the oases will be selected to estimate the combined effect of climate change and water management on wheat yield. Difference between estimated yields under current and recommended crop management will give an idea of the mitigation effect. The methodological framework is presented here.

Keywords: Crop models, epic, regional modelling, upscaling, wheat

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Smallholder Farmers' Contribution to Climate-Smart Agriculture

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The Mitigation of Climate Change in Agriculture (MICCA) Programme at the Food and Agriculture Organisation (FAO) supports smallholder farmer to contribute to mitigate climate change through the adoption of climate-smart agricultural practices. Currently four projects are initiated in collaboration with partners and will be developed and implemented in Tanzania, Kenya, Ecuador and Vietnam focusing on different farming practices and agro-ecological zones. The aim is to generate site- and practice specific data on the greenhouse gas (GHG) emissions of agricultural practices, as well as evidence on the mitigation potential when introducing new or climate-proofing current technologies, such as conservation agriculture, agroforestry and integrated food energy systems. Additionally, in these projects the farmers will be benefiting from the generation of co-benefits of these practices, such as fostering productivity increases, adaptation through increased ecosystem resilience and improved nutrient balances, as well as livelihood support by diversifying income sources.

Furthermore, the incentive mechanisms to support the transformation to climate-smart agricultural practices are reviewed and assessed, both through theoretical reviews and analysis of existing mechanisms, as well as in practice for the specific country and practice settings. Apart from carbon markets several mechanisms, such as credit schemes and contract farming systems, can provide interesting financing alternatives for terrestrial carbon projects, as a high proportion are developed outside existing crediting schemes. Several studies and analysis demonstrate that a radical rethinking is necessary on how agriculture and forestry could play a bigger role in market-based mechanisms, as well how different financing avenues for forestry and land use projects need to be organised.

Many agricultural practices have small net emission reduction potentials per hectare, but if the 404 million smallholder farms worldwide across different farming systems adopted these mitigation practices, a substantial impact on global emissions could be made. This conference contribution will demonstrate the potential that smallholder have to become part of the solution to climate change.

Keywords: Climate-smart agriculture, greenhouse gas emissions, incentive mechanisms, mitigation

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Forest-based Climate Change Mitigation in the Peruvian Amazon: Assessing Alternative Implementation Options

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Reducing Emissions from Deforestation and Degradation of forests (REDD) is considered a low-cost option to mitigate climate change. REDD cost assessments, however, tend to focus on opportunity costs only, and few studies have attempted to quantify associated implementation costs of proposed REDD measures, such as Payments for Environmental Services (PES) or Command-and-Control (C&C). Implementation costs can, however, be a key factor determining the potential of REDD as a mitigation measure. In this paper we study the cost-effectiveness implications of PES and C&C schemes considering key implementation cost items, such as liability establishment, coercion, and administrative costs. Field data for our analysis have been collected in the Central Peruvian Amazon, which is currently the focus of internationally supported initiatives to prepare for REDD. We set up a simulation model of farmers' land use choices and implementation costs based on observed enforcement strategies of regional environmental agencies. The model includes operational linkages between PES and C&C, such as the implications of imperfect monitoring and enforcement. Preliminary results indicate that the cost-effectiveness of PES hinges on effective enforcement strategies to the extent that payments may become economically uncompetitive under the current weak enforcement regime. We also find that remote and small-scale deforestation can be competitively addressed by well enforced PES schemes, whereas C&C is the most cost-effective conservation mechanism for larger-scale deforestation in well-connected locations. By quantifying the welfare and equity implications of alternative combinations of PES and C&C incentives we show that REDD is associated with hard political economy tradeoffs. The paper concludes with recommendations for the design of cost-effective and socially compatible REDD mechanisms in the Peruvian Amazon.

Keywords: Amazon, C&C, climate change, enforcement, implementation cost, land use, opportunity cost, REDD

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Monitoring Conservation and Livelihoods: Assessing REDD Effectiveness in the Juma Reserve, Amazonas, Brazil

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The 589 km^2 Juma Sustainable Development Reserve is one of the first certified initiatives of Reducing Emissions from Deforestation and Degradation (REDD+) in the Brazilian Amazon created by the Amazonas Sustainable Foundation (FAS). The benefits expected from the project are mainly divided in 4 programs: Strengthening of environmental monitoring and control; Income Generation through the Promotion of Sustainable Businesses; Community Development, Scientific Research and Education; and Payments for Environmental Services (PES), through the "Bolsa Floresta" Program. Apart from social and environmental co-benefits the project aims at avoiding roughly 190 Mt of CO_2 emissions in 40 years. This study assesses the initial conservation outcomes based on a comprehensive remote sensing analysis, and complements findings with results from representative farm-household and village-level survey data.

Land use of small-scale subsistence farmers was recorded via GPS and field interviews in. Beneficial and adverse effects of REDD actions on livelihoods were noted, as well as changes in land use practice. The various components of the benefits from the REDD initiative were rated by the local population in terms of importance for household's land-use decisions, due participatory workshops conducted by FAS. Five years of satellite images were processed to create a multitemporal forest cover map featuring areas of change.

A supervised approach for forest cover map classification with a Support Vector Machine trained by field data proved superior to regularly used unsupervised approaches of PRODES and CLASlite. Deforestation in the study area declined with continuing REDD+ implementation, and support to the project remained high. In qualitative interviews farmers highlighted improved tenure security and quality of education, apart from PES, as important explanatory factors.

Observed land-use change as well as future deforestation models suggest strongest deforestation pressure outside the reserve by cattle ranchers coming from the south. High resolution images can be used for up-to-date monitoring of remote areas for timely fact-finding missions. Stronger field presence of environmental enforcement authorities seems beneficial from a monitoring perspective. FAS has been making partnerships with government agencies and plans to establish more southern outposts and community schools.

Keywords: Conservation, livelihoods, monitoring, REDD, remote sensing

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N-oxides Fluxes, N_2O Sources, and Soil-profile N_2O Concentrations of Tropical Forests after Chronic N Addition

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N deposition is projected to increase in tropical region and emissions of climate-relevant N-oxide (NO and N_2O) gases are expected to rise. However, few studies quantify long-term impact of increased N availability on these gases and on the processes responsible for their production. We used N addition experiments to achieve N-enriched conditions in contrasting montane (3–4-yr N addition) and lowland (11–12-yr N addition) forests in Panama. Control and N-addition (receiving 125 kg urea-N ha $^{-1}$ yr^{-1}) treatments were represented by four (40 m $\times$ 40 m) replicate plots each. We wanted to 1) quantify changes in surface N-oxide fluxes during N addition in tropical montane and lowland forests and 2) assess the contribution of denitrification and nitrification to the surface N_2O fluxes and deduce which process might be dominant at lower depths. In the montane forest, N-oxide fluxes from N-addition plots were higher than the control. During the two-year measurement period (2008–2009), a two-fold increase in annual N_2O fluxes was observed while annual NO fluxes decreased from the N addition plots. Nitrification contributed $\geq$60 % to the N_2O flux from both treatment plots while $\leq$40 % was attributed to denitrification. In the lowland forest, N-oxide fluxes from N-addition plots were also higher than the control. Annual N_2O and NO fluxes from the N-addition plots remained comparable. Denitrification appeared to be the dominant process producing N_2O in N-addition plots during both dry and wet seasons. In the control plots, nitrification accounted for 70 % of the total flux during the wet season. At both sites, soil-profile N_2O concentrations in the N-addition plots were significantly higher than the control, starting at about 40-cm depth. High water-filled pore space ($\geq$80 %) at these depths suggests that denitrification might be the dominant process contributing to the measured N_2O concentrations.

Keywords: Chronic N-addition, denitrification and nitrification, N-oxides, tropical forest

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Mitigation of Methane Emissions from Rice Paddies: Alternate-wetting-and-drying in Farmers' Fields (Central Luzon, Philippines)

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Alternate wetting and drying (AWD) is a water saving strategy in irrigated rice production. The basic idea is to switch from continuously flooded rice fields to fields that alternately encompass flooded and non-flooded phases which can save up to 20 % of irrigation water. This can be applied without yield losses as long as the water level does not go lower than 15 cm below soil surface. In our study, we have assessed AWD as a means to mitigate methane emissions. While the principal potential of water saving as mitigation strategy has previously been shown on experimental farms, we intended to demonstrate the actual emission savings under farmers' practices.
The greenhouse gas (GHG) methane is produced anaerobically by methanogenetic bacteria. Hence flooded rice fields are a large source of methane emissions (in fact, the second largest anthropogenic source after ruminant livestock). Periodic aeration of the soil inhibits methane producing bacteria, so that AWD can reduce methane emissions by up to 50 %.
AWD is adopted in many rice producing areas already, but it is unclear to what extent the recommended irrigation protocols are followed by individual farmers. For an assessment and upscaling of actual emission savings, however, it is indispensable to do measurements in farmers' fields. In our study we analyse methane emissions on selected rice farms in Nueva Ecija (Central Luzon, Philippines) comprising farms that adopted AWD as well as those with continuously flooded fields. Our key findings are 1) reduction of CH_4 emissions under AWD as practised in farmers' fields is marginal and 2) there are only minor differences in N_2O emissions between AWD and continuously flooded fields.

Keywords: Greenhouse gases, irrigation, methane, rice, water management, water saving

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The Effectiveness of Global Carbon Mitigation Mechanisms – A Top-down Analysis. Reflexions from the Mata Atlantic Forest

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Global climate change and population growth poses important challenges to the world in the near future, especially issues related to food security and the supply of ecosystem services. The framework for carbon sequestration projects under the framework of Land Use, Land Use Change and Forestry (LULUCF) of the Clean Development Mechanism (CDM) could represent a valuable opportunity to protect severely endangered ecosystems like the Atlantic Forest and at the same time enhance the living conditions of the inhabitants of the surrounding areas. The present study is the result of an analysis of the feasibility of carbon mitigation projects in the municipality of Cachoeiras de Macacu, Rio de Janeiro State, Brazil. Using land cover maps and a stakeholder analysis this approach tries to identify the main barriers that are limiting the implementation of carbon sequestration projects in the region.

Difficulties to measure the available areas, the costs, the lack of local communities' engagement and finally the absence of stakeholders' participation are main concerns. Additionally, the specificity of the existing methodologies (that limits their replication) and demonstration of additionality represent important barriers. In Cachoeiras de Macacu, 27 % (264 km^2) of the municipality are potential lands for LULUCF projects. Lands are highly parceled and mainly represent pastures (194 km^2) or agricultural lands (36,47 km^2). Historically deforested areas (like Cachoeiras de Macacu) have relatively high suitable areas for LULUCF initiatives, but also significant demand for lands for settlements and food production Nevertheless, the existing institutional infrastructure and the megacities in the vicinity of the area make a future appliance of Payment of Environmental Services in the region possible. There is a need to develop a more holistic and integrative approach that incorporates carbon mitigation alternatives to other ecosystem services.

Keywords: Brazil, Cachoeiras de Macacu, Mata Atlântica, payment for ecosystem services

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Towards Reducing Emissions from All Land Uses: A Robust Equation for Estimating Total Tree Biomass in Tropical Agricultural Landscapes

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Allometric equations are a useful tool for estimating biomass carbon by relating tree biomass to measurable parameters such as diameter at breast height. While equations have been developed for separately assessing above- and belowground biomass for conventional areas such as forests, and significant success has been achieved in quantification of forest carbon stocks; assessment of total tree biomass in agricultural landscapes has remained a great challenge because of lack of accurate, reliable and cost effective methods for monitoring carbon storage in trees in these landscapes. Therefore, those marginal landscapes have long been neglected both in their emissions and also carbon stocks and sequestration potentials. We established a common generic equation for estimating total tree biomass (above- and belowground) by destructively sampling 72 representative trees randomly selected in three 100 km^2 sentinel sites representing agriculturally dominated landscapes in western Kenya. The results show that above- and belowground biomass fractions represent 77.4 and 22.6 % of the total tree biomass, yielding an overall ratio:shoot ratio of 0.29, which however varied along an altitudinal gradient. Diameter at breast height is a good predictor of total tree biomass, explaining 99 % of the variability observed in total tree biomass and consistently predicted biomass with low error across different tree size and among the three blocks evaluated. Application of the belowground equation is superior to the use of root:shoot ratios. The equation developed estimated representative landscape biomass to be 47.1 Mg ha^{-1}. Using a conversion factor of 0.48 (biomass weighted mean) determined from elemental analysis of tissue carbon of trees harvested, agricultural mosaics of western Kenya are estimated to hold 22.6 Mg C ha^{-1} of biomass carbon. We confirm that diameter at breast height provide a more straightforward and robust means of estimating total tree biomass in heterogeneous agricultural landscapes. The equation presented in this study will significantly improve the accuracy of estimating biomass carbon in agricultural landscapes without the intermediate steps and associated errors of determining above- and belowground portions.

Keywords: Aboveground biomass, allometry, belowground biomass, carbon, western Kenya

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Economic Value of CDM Afforestation with Co-benefits in Irrigated Drylands of Central Asia

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Increasing water scarcity and cropland degradation endanger rural livelihoods in the irrigated drylands of Central Asia. Establishing Clean Development Mechanism (CDM) afforestation projects is one option to remediate marginal croplands and in turn improve rural incomes. We used Net Present Value (NPV) estimates over seven years of afforestation projects taking into consideration not only the value of carbon sequestered as temporary Certified Emission Reductions (tCERs), but also multiple tree products such as leaves as a fodder, fruits, and fuelwood as a means to increase profits. Opportunity costs of afforestation were estimated by comparing this land use with a cultivation of cotton, wheat, maize, and rice, which are the dominant crops, under various irrigation rates.

At current world price for tCERs (4.76 USD), the profits from CDM afforestation alone ranged between 733 and 5,911 USD ha^{-1} and exceeded those of cotton and wheat even under an optimal water supply. Rice cultivation was the most profitable among the annual land use options but required large, constant amounts of water, which are unavailable for marginal lands. Nevertheless, the share of tCERs in total revenues, which ranged within 519–913 USD ha^{-1}, was insufficient to cover initial CDM investments. However, given the low demand for irrigation water by trees (6–30 % of that for the annual crops), tCERs could be an additional option to cope with water scarcity. Conversion to CDM afforestation on marginal cropland would save up to 15,000 m^3/ha/year of water at the current price of tCER. At the increased price of 44.8 USD per tCER afforestation as an alternative to rice cultivation on marginal land would save annually about 24,000 m^3/ha.

Keywords: Marginal croplands, net present value, non-timber products, temporary certified emission reductions

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Permanence in REDD+ Projects: The Case of Eco-charcoal Policies

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Permanence is a key issue in the global negotiations on REDD+. Our research project analyses the options for policies to increase permanence in a case study of the conservation in the worlds first REDD project to issue carbon credits under an internationally accepted standard, the Kasigau Corridor REDD project in Kenya by Wild Life Works. In the Kasigau project, the main driver of forest degradation is illegal charcoaling. Despite being illegal, large parts of the local population rely on charcoaling as their main source of income. As the charcoal gets exported and trades even internationally, reducing local demand alone won't be enough to reduce forest degradation.
As a mitigiation policy the project proponents aim to introduce eco-charcoal factories. At such a factory, charcoal is made from fast growning twigs and shrubs. This eco charcoal can be a full and equivalent substitute for conventional charcoal, but requires some capital investments for the production sites. This let to the idea of building village based factories for eco-charcoal, where the community can sell twigs and shrubs, thus replacing the income lost due to the enforcment of the charcoal ban.
We are using a stated time allocation experiment to predict the effects of several different policies for implementing such a community supported eco-charcoal project under varying charcoal price conditions in 1000 households. Some of the scenarios include a conditionality of the price paid for eco charcoal raw material on the number of people caught charcoaling illegally, thus introducing a collective action situation. Our main goal is to determine the effect of the price for eco-charcoal raw materials paid to the community on the level of illegal bush charcoaling. We are also investigating into intra household shifts in labour allocation.

Keywords: Case study, conservation, permanence, REDD

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Effects of REDD Policy on Potential CO_2 Emission Reduction and Poverty Alleviation

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Reducing emissions from deforestation and forest degradation (REDD) is considered to be a low cost carbon mitigation measure in comparison to other actions. Nevertheless, it has also been questioned to which extent REDD will be sufficiently attractive to change the current land use decisions. Land use decisions are largely based on opportunity, transaction and implementation costs. Another concern is related to REDD effects on poverty because forest conservation in countries where the level of poverty is high may have adverse equity implications.
We determined opportunity, implementation and transaction costs for landholders and conservation agencies through surveys, focus groups, expert interviews and the study of literature in two case studies in Nicaragua and Costa Rica. Combined with estimates of poverty levels and tenure categories we aimed to determine the land use and poverty impacts of REDD for its implementation through Payment for Ecosystem Services programs (PES).
Preliminary results suggest that under various carbon price scenarios agricultural land use continues to be the more profitable land use option in large parts of the study area. Results also point to the benefits of scale in that larger forest conservation projects reduce per land unit transaction costs of both national and voluntary carbon market frameworks. Regarding impact on poverty, it seems that upfront investment costs (transaction and implementation costs) reduce the ability of poorer landholders to enrol in respective programs so that higher income groups are likely to benefit more directly from national or international REDD markets. For the case of Nicaragua, it seems that indigenous communities have better chances to participate in REDD PES schemes due to clearly defined property rights. Data also shows that this group is better off in terms of income. The results help formulate suggestions for the design of national REDD programs, for example to reduce enrolment costs and thus support participation of lower income groups.

Keywords: Central America, opportunity cost, payment for ecosystem services, poverty, reducing emission from deforestation and forest degradation, transaction and implementation costs

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Farm Management Strategies to Enhance the Farm Performance in Changing Climate: A Case Study in the Mid-hills of Nepal

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A multi-level study was carried out to identify and explore farm resource endowment and ecological performance of mixed farming systems (improved and traditional) in Baglung district of Nepal. This study focused on farm input resources, soil organic matter-carbon (SOC) and nitrogen dynamics. Farm and soil survey was carried out in 62 farms in two communities: Amarbhumi and Tityang. A representative farm from each group was selected for further study using the Farm DESIGN model. Both principal component analysis and hierarchical cluster analysis was carried out to identify the farm typology. In the case study region livestock and free access to common natural resources (CNRs) were central components of the farming system. It was observed that animal density was high (5.1 LU ha^{-1}) in both communities. It was also observed that 47.9 % and 43.1 % DM intake for livestock was derived from CNRs in Amarbhumi and Tityang, respectively. The contribution of CNRs on carbon balance at farm was observed to be very high (45 %). In the Amarbhumi FYM/compost applications were high (44 Mt) with improved farms than traditional farms (32 Mt) compared to the Tityang (21 Mt), where there was no difference in application rate between farm groups. The soil analysis results showed that increases in SOC content at improved farm amounted to 11 and 22.4 % higher in Amarbhumi and Tityang, respectively. The results also showed that soil N% in improved farms in both communities were significantly higher; 0.46 and 0.25 % than the corresponding values of traditional farms which were 0.41 and 0.20 %, respectively. At the farm level, result showed that farmers pursuing sustainable soil management (SSM) were using input resources more efficiently than traditional farms. It was observed that improved farms at Amarbhumi and Tityang had 6.3 % and 47.6 % higher N-efficiency than traditional farms, respectively. This study provides the evidence that there is a wide scope and direct benefits associated with the use of improved SSM practices in terms of adaptation and mitigation of climate change.

Keywords: Farm management, improved farm, nitrogen efficiency, resources, soil organic carbon, traditional farm

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Crop abiotic stresses

Yield and Water Productivity of Quinoa (*Chenopodium quinoa* Willd.): A Potential Crop for Saline and Dry Marginal Lands

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Quinoa is a facultative halophyte crop and can grow in extremely saline conditions. A field lysimeter experiment was carried out to investigate the effects of salt and drought on the seed yield, total biomass production (DM), harvest index (HI) and water productivity (WP) of quinoa (cv. Titicaca). Five irrigation water salinity levels (0, 10, 20, 30 and 40 dS m^{-1}) applied during flowering were combined with either full irrigation (FI) or progressive drought (PD) during the seed filling stage. Salinity did not significantly decrease DM production but had a negative influence on HI. Salinity between 20–40 dS m^{-1} decreased the seed yield by 33 % below the ca. 2300 kg ha^{-1} of the 0 dS m^{-1} treatment. PD significantly decreased both the seed yield and the HI by ca. 10%; when soil was dried to the wilting point. No significant effect of drought and salinity was observed on the ET-based water productivity of seed production, however; higher salinity levels significantly increased total biomass water productivity (WP_{DM}) compared to 0 and 10 dS m^{-1} salinity levels. In addition, drought treatment increased WP_{DM} significantly (3.36 g m^{-2} mm^{-1}) compared to FI treatment (2.80 g m^{-2} mm^{-1}).

In summary, increasing irrigation salinity levels, caused reduction in the seed yield and HI, but increased WP_{DM}. When the crop was subjected to severe soil drying, the seed yield decreased but WP_{DM} increased significantly. With respect to the seed yield and HI, no significant differences between 20, 30 and 40 dS m^{-1} salinity levels were observed, which shows that this quinoa cultivar (cv. Titicaca) acclimates to saline condition when exposed to high salt concentrations above 20 dS m^{-1}.

Keywords: Quinoa, salt stress, seed yield, soil-drying stress, water productivity

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Functional Responses of Baobab Seedlings to Drought Conditions: Differences between Western and Southeastern Africa

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The African baobab, an important multipurpose tree species, is well-known for its drought tolerance at adult stage. However, there is little information on the ability of this species´ seedlings to withstand drought. Therefore, the aim of this study was to investigate the functional responses of baobab seedlings under a short-term soil drought stress. As genetic differences between baobab trees from western and southeastern Africa have been reported, seeds were collected in both Mali and Malawi (western and southeastern Africa, respectively).

Baobab seedlings were found to use a number of mechanisms to cope with drought. First, leaf area was reduced due to leaf shedding, though not all leaves were shed and even some leaves with altered morphology were formed. Secondly, under drought, relatively more biomass was allocated to the root system. Thirdly, as baobab seedlings had a tight stomatal control, under drought conditions photosynthesis and transpiration were significantly reduced while leaf water potential barely changed. As drought persevered, non-stomatal limitations on photosynthesis became important. Water stored in the taproot was being used for the salvation of part of the old leaves, for the formation of new ones, for the formation of new roots, and for the maintenance of metabolic processes. There was a significant correlation between water content of the taproot and stomatal closure.

Differences between the drought responses of baobab seedlings from different origins were observed: Malawian seedlings were able to retain more leaves and to form more new ones, while Malian seedlings tended to allocate more biomass to their root system. Therefore, baobab seedlings from western Africa showed more drought-avoidance characteristics. These different strategies between Malawi and Mali agree with genetic differences between baobab clades, and suggest that superior planting material in terms of drought tolerance can be selected.

Keywords: Adaptation, baobab, drought avoidance, photosynthesis, semi-arid regions, stem succulence, stomatal conductance

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Effects of Soluble Salts on Water Holding Capacity of Hydrophilic Polymers: A Case Study on Geohumus

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Gel-forming polymers that can absorb water up to 1000 times their weight are considered as ameliorants of soil water supply in arid and semi arid areas. A new product belonging to these polymers, called Geohumus, can absorb pure water up to 40 times of its weight. However, when Geohumus is applied under field conditions, soil physical condition and the ion concentration of soil water may interfere with this water absorption capacity. In order to quantify these effects Geohumus was imbedded in variable concentrations and types of salts, a standard nutrient solution as well as soil extracts for 2 hours and the water absorption quantified. Significant differences in water holding capacity (WHC, g of water per g of Geohumus) between treatments were noticed with all treatments lowering the WHC compared to that measured in distilled water (13.5 g H_2O g^{-1}), sandy soil extract (8.2 g H_2O g^{-1}) and sandy soil extract with nutrient solution (4.4 g H_2O g^{-1}). Testing the WHC over a wider range of salt concentrations *i.e.*, 0.01 to 0.05M, WHC of Geohumus decreased in the order: KNO_3, NH_4NO_3, NaCl, K_2SO_4, $MgSO_4$, $Al_2O_{12}S_3 \cdot 13.4–14.5H_2O$, and $FeSO_4 \cdot 7H_2O$. WHC and concentration of salts were negatively correlated. Valance II elements impeded Geohumus water absorption capacity more than valances I elements. In conclusion, similar to other hydrophilic polymers, WHC of Geohumus is sensitive external salt concentrations which are realistic for *in-situ* soil solutions. These results imply that when Geohumus is applied under field conditions interactions between soil type and soil solution composition should be considered.

Keywords: Drought stress, field water balance, soil solution concentration

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Effect of Drought on the Mobility of Foliar-applied Boron in Plants

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Boron is considered to be phloem immobile or to have only limited phloem mobility in many higher plant species, where it is transported along the transpiration stream and accumulates in the margins of leaves. However, one would expect a phloem transport of boron if the back diffusion into the xylem in some way be prevented and it may be possible under reduced transpiration, as it was shown for *Ricinus communis*. In this research, the distribution of foliar-applied B in green gram plants (*Vigna radiata* L.) under varying transpiration rates was evaluated in a greenhouse experiment during 2009. This research also evaluated the possibility to use strontium as an indicator for the cumulative transpiration of a plant. The experiment was laid out in a complete randomised block design comprising three moisture levels (75, 50 and 25 % WHC), two boron levels (100 and 0 mM B) and two harvest dates. The top of the second trifoliate leaf was immersed in 100 ml of 100 mM boric acid solution for one hour. In addition, 20 ml of 10 mM Strontium chloride (SrCl2) was applied directly to the root of all plants. Results showed that most of the B absorbed from the foliar application was accumulated in the treated leaves indicating that reduced transpiration did not support the phloem B transport out of the leaves. Sr uptake and its distribution within the plant parts were related to the transpirations rate and can be used as a reference for transpiration measurement.

Keywords: Boric acid, boron, drought, phloem mobility, strontium chloride, transpiration

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Monitoring Water Stress Responses of *Ipomoea aquatica* (Forssk.) by Thermal Imaging in Different Soil Materials of Northern Thailand

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Water morning glory, *Ipomoea aquatica* (Forssk.), is a widely used leafy vegetable throughout Southeast Asia and China. The fast growing plant produces high biomass with a soft watery tissue. This study focuses on the responses of water morning glory to water deficit under controlled conditions.

Three cemented soil basins (8 m $\times$ 1 m $\times$ 1 m) under a plastic shelter were filled with soil material representative for northern Thailand, taking care that the natural layering and bulk density was altered to the least extend possible. The original soil bodies were Acrisols from a mountainous site at Mae Rim District (a red, well drained, acid clay loam soil derived from granite on a slope), Vertisols (a brown, clayey alluvial soil deposited on flood plain) from Mae Ai District and Regosols (a well drained loamy sand developed on a middle terrace) from Mae Jo, Sansai District.

I. aquatica (cv. 'Reptan') was planted and three weeks drip irrigated keeping the soil close to field capacity (<-100 mbar) until complete soil cover. Each soil basin was divided into two longitudinal segments. On one segment of each soil basin irrigation was continued for control and on the other segment irrigation was stopped for monitoring water stress responses.

Weather data were collected on site and matric potential was monitored with tensiometers. Stomatal resistance was determined once a day by a porometer (Decagon SC-1) and thermal images were acquired with an IR-camera (Infratec Variocam) at the same time. Crop water stress index (CWSI) was calculated as (TC - Tbase) / (Tmax - Tbase), where TC is the mean canopy temperature, Tmax is the upper threshold temperature of leaves where transpiration is suppressed by vaseline coating and Tbase is the temperature of water sprayed leaves and therefore the threshold for maximum evaporative cooling. After ten days of drought the plant material was harvested for determining above ground fresh and dry biomass.

CWSI based on thermal imaging showed a high correlation with the stomatal resistance. It was possible to visualise the differences between well watered and stressed plants by thermal imaging before visible signs of wilting started.

Keywords: CWSI, irrigation, leaf temperature, matric potential, stomatal resistance, water morning glory

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Effect of Elevated Tropospheric Ozone on the Grain Quality of Rice

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Many emerging Asian countries are experiencing dynamic economic growth, which has led to environmental problems such as rising air pollution. In large parts of India and China, tropospheric ozone concentrations above 60 ppb are seen frequently even in rural areas, which affects both human health, and the productivity of agricultural crops. In the coming decades, ozone concentrations are expected to rise even further in these parts of the world due to the combined effects of global change and economic growth. Ozone affects rice production in various ways. It is taken up through the stomata during photosynthetic gas exchange and causes reduced photosynthetic capacity, oxidative stress, accelerated senescence, and ultimately a reduction in yields that can reach more than twenty percent. The quality of rice straw has also been shown to be affected by ozone. However, the effects of ozone on the quality of the rice grain have not been investigated in detail.

Ozone fumigation experiments were conducted in Akagi (Japan), in which plants from eight different rice genotypes were exposed to four different ozone concentrations throughout the growing season: charcoal filtered air (= clear air with almost no ozone), ambient ozone concentration, 2 × ambient ozone concentration, and 2.5 × ambient ozone concentration. Grain samples were taken at maturity, and were analysed for grain quality traits. Protein concentration increased consistently with increasing ozone dose in most genotypes. Phenolics concentration was strongly elevated in pigmented genotypes but did not show any response to ozone fumigation. Iron and zinc concentration were differently affected in different genotypes, showing ozone induced increases in certain varieties and decreases in others. Further analyses are being carried out to investigate crude lipid concentration, thousand kernel weight, grain colour and shape, as well as viscosity. This study suggest that grain quality is affected by ozone, and that genotypic difference occur in the response to ozone stress.

Keywords: Environmental stress, food security, global change, ozone, rice

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Impact of Post-anthesis Water Deficit Stress on Water Use Efficiency and Yield in Mediterranean and mid-European Wheat Cultivars

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Cultivation of wheat prevails in the subtropic and temperate climates with water shortage being frequently a severe constraint during the late season particularly in Mediterranean and continental areas. Hence we examined wheat cultivars from Mediterranean (cvs. Golia + Gönen) and temperate climates (cvs. Monsun, Taifun, Naxos and Triso) with respect to their performance of water use and yield under post-anthesis water deficits.

Plants were raised in pots under a rain shelter from April to August 2007, 2009 and 2010 receiving the same optimum treatment throughout the season apart from a 3 week period after heading in which soil moisture was either maintained at field capacity or was lowered and kept at 75 % to 50 % of the available field capacity by deficit irrigation. The 2-factorial experiments (cvs. $\times$ water) had a complete block design with 5 replicates.

Water use efficiency (WUE), and its components, evapotranspiration efficiency (ETE) and harvest index (HI), displayed consistent differences between the cultivars each year resulting in a stable rank order for WUE (Triso $\geq$ Naxos $\geq$ Monsun $\sim$ Taifun $>$ Golia $>$ Gönen) though temperature varied considerably between the 3 years. Post-anthesis water deficits had just slight effects on WUE in 2007 and 2009, but improved it significantly in 2010. ETE as well as HI correlated equally well with the variation in WUE due to cultivars, irrigation regimes, and years.

Deficit irrigation lowered grain yield by only 6 and 9 % in 2007 and 2010 resp., but not in 2009, and did not change ranks among cultivars (Triso $\sim$ Naxos $\sim$ Monsun $>$ Taifun $>$ Golia $>$ Gönen). In 2007, irrigation regimes interacted with cultivars obviously due to a lowering of the yield by deficit irrigation in all cultivars (6–12 %), but not in Taifun. In 2010, all cultivars responded similarly to water deficits (8–15 %, no interaction cvs. $\times$ water).

Hence, all tested cultivars seemed to be similarly susceptible to mild post-anthesis water deficits. However, since Mid-European cultivars displayed lower WUEs than Mediterranean ones and since yield of the former ones under stress exceeded that of each of the latter ones without stress, conclusion is reasonable that the 2 Mediterranean cultivars are not better adapted to the future Mid-European climate.

Keywords: Adaption to drought, components of water use efficiency, wheat of different origin, yield

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Acclimatation of Co-occurring Tree Species to Water Stress and their Role as Site-indicators in Mixed Pine-oak Forests in Northeast Mexico

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Mixed pine-oak forests are widely distributed in the higher altitudes of the eastern Sierra Madre, Mexico, including ecologically and economically important tree species. These forests are exposed to extreme climatic conditions of high temperatures and low precipitation distributed irregularly through the year. Under field conditions, water stress or rather soil water availability is one of the major limiting factors in plant growth and affects most physiological processes in these ecosystems. Moreover climatic change and human activities accelerate forest degradation and deforestation. In order to characterise the acclimatation of native species to these stresses, leaf water (Ψw) and osmotic potentials (Ψs) of *Juniperus flaccida*, *Pinus pseudostrobus* and *Quercus canbyi* were measured under natural drought and non-drought conditions under two different aspects in the Sierra Madre Oriental. Factorial ANOVA revealed significant differences in Ψw and Ψs between two aspects, species and sampling dates. In general, all species showed high predawn and low midday values that declined progressively with increasing drought and soil-water loss. Seasonal and diurnal fluctuation of Ψw and Ψs were higher for *J. flaccida* and *Q. canbyi* than for *P. pseudostrobus*. Leaf Ψw and Ψs were mainly correlated with soil water content, while Ψs of *P. pseudostrobus* were hardly correlated with environmental variables. Thus, species showed different strategies to withstand drought. *P. pseudostrobus* was identified as a species with isohydric water status regulation, while *J. flaccida* and *Q. canbyi* presented water potential patterns typical for anisohydric species. Thus, isohydric behaviour is of advantage during severe but short periods of drought, while anisohydric water status regulation is favourable during long-term drought conditions of minor intensity. Detailed knowledge about the type of water status regulation may be a critical factor for plant survival and mortality in the context of climate change. Nevertheless, for precise conclusions about the advantages and disadvantages of each type, further long term investigations are required.

Keywords: *Juniperus flaccida*, osmotic potential, *Pinus pseudostrobus*, *Quercus canbyi*, restoration, water potential

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Development of a Drought Stress Scale by Different Parameters Using *Lablab purpureus* as Model System

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Due to the changing climatic conditions, there is an enlargement of land areas with insufficient rainfall and therefore a reduction in the cultivated area for common crops. Hence, it is now important to find plants that are adapted to these drought conditions. *Lablab purpureus* (L.) Sweet which is grown mainly in Africa and South Asia is considered to be drought tolerant. The species *L. purpureus*, common name is *e.g.* hyacinth bean, is a member of the family Fabaceae. This plant is grown in homegardens or is part of mixed cropping schemes (*e.g.* with corn). It has a function as food, forage, herbal medicine, green manure, pharmaceutical or nutraceutical. In this study we compare about 20 *L. purpureus* genotypes collected in different countries and screen them for their tolerance to drought stress. We use different methods to achieve a definitive statement on the drought tolerance of the individual genotypes by combining the methods. This allows us to create a possible drought tolerance ranking of *L. purpureus* genotypes. Methods include PAM Imaging; here we use the fast measurable stress-indicating factor Fv/Fm to gain information about the state of the photosynthetic apparatus. Other methods are conductance measurements and determination of the leaf turgor pressure by non-invasive probes, in order to obtain information about the water status of the plants. Furthermore, we investigate the stress response of plants in relation to their changes in fresh mass and dry mass. First results are discussed. In the future we want to establish a stress scale to identify and characterise further drought tolerant plant species.

Keywords: Drought tolerance, *Lablab purpureus*, stress scale

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Uptake and Translocation of Boron in two Different Tomato Genotypes

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Boron is a micronutrient essential for the normal plant growth and development. Similar to calcium, it has important roles in quality factors of many agricultural products. The role of boron in plants has been a matter of research over the past decades, however, the mechanism of boron uptake by plants and loading into xylem are poorly understood. A series of hydroponic culture experiments were conducted with two different tomato (*Lycopersicon esculentum* L.) genotypes (wild type; Boron-efficient, and mutant; boron-inefficient) to determine whether the mutant has defect in boron uptake by root cortex cells beside known defect in active xylem loading which has been detected in Arabidopsis. For this purpose, plants were exposed to different boron concentrations of 0.0, 0.1, 0.5, 2, 10, 15, 20, 25, 30, 35 and 100 μM in different experimental set-up. Boron concentration was determined in root symplastic sap and xylem exudate of the both genotypes. The results showed that boron concentration in root symplastic sap of the mutant plants was significantly lower than the wild type in all treatments when compared to each other. Low boron concentration was determined in xylem exudates of boron mutant plants as well. The result also showed the active xylem loading was present in the wild type but not in the mutant, suggesting defects in boron uptake and root-to-shoot translocation of boron in the mutant at low boron supply. This defect was not seen at high boron supply, indicating a passive rather than active uptake and translocation of boron in tomato plants in high boron supply. Nevertheless, wild type showed no boron deficiency under all boron concentrations except zero amounts.

Keywords: Boron, symplastic cap, tomato, translocation, uptake, xylem exudate

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Growth Performance of *Eucalyptus camaldulensis* under Saline Conditions in Sudan

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Soil salinity is a critical global problem, especially in arid and semi-arid regions in which Sudan is no exception. In such regions soluble salts accumulate in the soil because precipitation is greatly outweighed by evaporation. Although *Eucalyptus camaldulensis* is an exotic tree species, however it proved successful and is extensively grown in irrigated plantations in Sudan. *E. camaldulensis* is chosen for this investigation for its high productivity in a relatively short rotation. Sensitivity of *E. camaldulensis* to water deficit conditions is well documented. In the present work our main goal is to further evaluate the performance of *E. camaldulensis* under salt stress conditions. *E. camaldulensis* seedlings (height 32.4 cm) were subjected to a relatively wide range of salt stress: 0 (control), 30, 50, 80 and 100 mM NaCl for four weeks under nursery conditions. Growth performance (shoot height, stem diameter and leaf formation rates) was regularly monitored twice a week. At harvest, each plant was separated into root and shoot systems to evaluate the effect of the treatment on biomass production, accumulation and partitioning. Dry mass was subsequently determined for all plant fractions after oven drying (60ºC for one week). Initially, growth was unaffected by salt treatments until the second week. However, significant reductions were observed towards the end of the exposure period. Among the growth parameters analysed leaf formation rate was the most sensitive compared to stem height and stem diameter growth rates. Biomass showed significant reductions in both shoot and root dry mass especially in plants that received the highest salt concentrations. Based on these results and observations it might be suggested that *E. camaldulensis* is sensitive to salt stress and is rather unsuitable tree species to be used in sites affected by high levels of salinity. Since leaf formation is tightly associated with shoot apical meristem activity, the current findings obviously points to a link between salinity and plant hormone status. Therefore, it would be helpful to conduct further experiments including some hormone analysis to validate these speculations and to find explanations for the physiological events responsible for the poor performance of *E. camaldulensis* under saline soils.

Keywords: *Eucalyptus camaldulensis*, growth, salt stress, soil salinity, Sudan

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Effects of Genistein on Nodulation, Nitrogen Fixation and Physiological Attributes of Soybean under Salt Stress

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Legumes are highly important food, feed and biofuel crops, that can enter into a symbiotic relationship with specific soil bacteria called rhizobia. This interaction results in conversion of atmospheric nitrogen into useable forms of nitrogen, thus reducing/replacing fertiliser demand. Isoflavones, such as genistein in soybean play important roles in plant-microbe interactions, c.f., the legume root nodule symbiosis. Therefore, iwe evaluated the role of exogenous genistein in the *Bradyrhizobium* inoculation medium on nodulation, nitrogen fixation and some physiological attributes of soybean grown under salt stress. Soybean seeds (L17) were sown into plastic pots filled up with autoclaved perlite and vermiculite.The pots were placed into a growth cabinet (L/D=16/8 h, T=28/25°C), and watered with full strength of Broughton and Dilworth solution. *Bradyrhizobium japonicum* (CB1809) was cultured in liquid YMB culture, after 24 h genistein was added into YEB to reach final concentration of 10 μM. The five days old plants were inoculated with a liquid YMB and watered with B&D solution containing 8 mM KNO_3 and 0, 25, 50 and 100 mM NaCl. Four weeks after inoculation, maximum photochemical efficiency of PSII (Fv/Fm), photosynthetic rate, stomatal conductance and transpiration rate were measured. Number of nodules and nitrogenase activity (GC method) was assayed. Fresh leaves were frozen in liquid N_2 for antioxidant enzyme activity assay. There was a significant difference between presence or absence genistein on nodule number and nitrogenase activity. Genistein increased nodule number and nitrogenase activity in each level of salinity compared with control. Moreover, genistein enhanced maximum photochemical efficiency, photosynthetic rate, stomatal conductance and transpiration rate while catalase, superoxide dismutase and peroxidase activity in leaves and roots were not affected by genistein but salt stress induced large and significant changes on both photosynthetic parameters and antioxidant enzyme activity. The former was suppressed and latter was amplified. There was significant decrease in nodule number and nitrogenase activity because of salt stress. According to these results it can be deduced that, genistein application into rhizobia inoculant improves plant growth through improved nodulation and nitrogen fixation in both normal and salt stress conditions.

Keywords: Antioxidant enzymes, genistein, nitrogen fixation, salt stress, soybean

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Adaptation of the First Filial Generation of Quinoa to Salinity after Parental NaCl Treatment

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At present, many regions are not available because of soil salinity. Irrigation with saline water increases soil degradation and result in further losses of cultivation areas. Utilisation of halophytic plants is an option for land reclamation and recovery. Quinoa (*Chenopodium quinoa* Willd.) is an important crop in the South American highlands that is increasingly utilised in Europe as an organic food product. Because of its high-quality nutrient content as well as resistance against diverse abiotic stresses, the FAO suggested quinoa as a future candidate in food security programs. Persistence to drought and salinity distinguish quinoa for cultivation in arid regions.

During development, seed and seedling are dependent on the parental deposited reserves, before the root system can assimilate nutrients. Quinoa seed germination rate and seedling viability were increased after parental NaCl treatment. Advanced seed swelling cannot completely be explained by increased ion content for osmotic regulation, because the amount of carbohydrates was decreased. Rather, the suction pressure was improved by low levels of matrix potential in the seed hull. By exclusion of Na and Cl at the level of the seed coat ion homeostasis was mostly maintained.

High salinity (500 mM NaCl) increased the protein content in embryo and perisperm. We assume that increased parental effort of N plays a crucial role for the viability of the filial generation under extreme stress. As a main source of N metabolites, seed storage proteins are major reserves in most common crops. It was observed, that the production of this protein class was increased during grain filling at the presence of vitiating circumstances. Thus, the source of basic nutrients for the filial generation was enhanced, resulting in increased stress resistance and viability. When affected by salinity, improved germination of quinoa might therefore be conditioned by an increased seed N reserve, such as seed storage protein.

Because development of genotypes with improved salt tolerance for common crops evolves very slowly, comprehension of naturally present mechanisms gains in importance. Targeted breeding for crops with high salinity tolerance, fertility and productivity, such as quinoa, is therefore an increasing option towards reclamation and recovery of barren area.

Keywords: *Chenopodium quinoa*, NaCl treatment, salt stress, seed morphology

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Root Functional Architecture: Modelling the Root Zone Dynamics of Water Uptake by Trees

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Root architecture plays a major part in determining a root system's ability to function effectively and efficiently in its essential roles of anchorage and the capture of soil resources. The characteristics of root development that are conventionally considered to be the main determinants of root architecture are the rate, angle, and duration of root growth and the pattern of root branching. Water uptake by plant roots is a main process controlling water balance in field profiles and is vital for agro-ecosystem management. We report the results from a field experiment in which we examined the spatial and temporal patterns of water uptake by trees in an orchard. Time Domain Reflectometry (TDR) was used to measure changes in the soil volumetric water content, and lysimeter was used to monitor drainage and evapotranspiration in the soil. The 2D depth- and radial-wise distribution of roots was determined from the average root-length density of the same sample within the root zone.

In this contribution we examine variations in soil physical, chemical, and biological properties and their impact on root growth. Finally, we describe how the concept of root functional architecture can improve the integration of research advances from fields operating as independent disciplines and improve our understanding of soil ecosystems.

When the surface soil layers were uniformly wet, 80 % of the trees water uptake occurred in the top 0.47 m of the root zone, in which approximately 80 % of the tree's roots were located. This study highlights the importance of root distribution and pattern in regulating soil water use and thereby improving endurance of plants to seasonal droughts for sustainable agricultural productivity.

Keywords: Environmental effect, root architecture, TDR, water uptake

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Application of Plant Growth Regulators During Premature Fruit Drop of Mango for Identifying the Key Physiological Factor

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In the mountainous area of North Vietnam mango (*Mangifera indica*) production is an important source of income for farmers, especially since the initial fruit growth period occurs during the dry season whereas other crops have not yet initiated (maize) or are just about to commence (rice) the growth and development cycle, hence are more dependent on rainfalls. The development of mango fruit partly during the dry season causes premature fruit drop, which may result in severe crop losses. Irrigation systems are difficult to establish in the study area because of limited water resources and costly investments for the famers. Fruit drop prevention by the use of plant growth regulators was tested as a possible alternative. Among others, CPPU spray applications showed that fruit retention can be increased up to 8-fold compared to the control treatment. However, for a better understanding of the underlying physiological mechanisms of fruit drop, Ethephon, a fruit drop inducer, was compared to CPPU in subsequent experiments. Colour, size and weight of fruit as well as the fruit detachment force (FDF) were measured at timely intervals after spray application of each individually sampled fruit. Colour was measured with a spectrophotometrically and hue angle (H°) was calculated for the fruit beak and shoulder. Results indicate that fruit with a high H° on either fruit position had a reduced FDF with colour changes occurring first at the fruit beak. Fruit parameters were further used to discriminate between fruit as visually healthy and about-to-abscise. About 70 % of the variation in FDF of visually healthy fruit was explained by fruit length and pedicel diameter. Fruit that were visually healthy but showed a reduced FDF may be explained by internal physiological factors which are related to the onset of the abscission process. Therefore fruit carbohydrate concentration and auxin transport capacity of the pedicel are currently analysed and will be presented at the conference. The results from those physiological parameters may help to identify the health status of fruit beyond their visual external appearance.

Keywords: Auxin, carbohydrate, CPPU, Ethephon, fruit pysiology, *Mangifera indica*, mango, plant growth regulator

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Effect of GA3 on Seed Germination of Soybean Cultivated under Water Stress and at Different Planting Dates

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Priming is one of the seed enhancement methods that might result to increase seed performance (germination & emergence) under harsh conditions, such as salinity, high temperature and drought. This experiment was carried out to study the effect of GA3 on seed germination characteristics of soybean [*Glycine max* (L.) Merr.] produced under different water deficit levels at different planting dates. A factorial experiment was conducted within a completely randomised design at the seed & plant certification and registration research institute, Karaj, Iran. M7 cv. seeds were produced under three levels of water deficit: 50 mm (no deficit), 100 mm (middle deficit) and 150 mm (severe deficit) evaporation from pan class A, at two planting dates: 22 May and 22 June. GA3 was applied at 6 different concentrations (0.1, 0.2, 0.3, 0.4 mM GA3, distilled water, no distilled water and no GA3). Our results showed that by increasing water deficit on mother plants seed quality characteristics were significantly reduced in planting date of 22 may. Those results were supported by Accelerated Ageing Test as well as standard germination test recommended by ISTA. Where, in planting date of 22 June, by severe deficit the seed quality was not affected significantly. The results of experiment showed that using 0.3 mM GA3 reduced deteriorated seeds (15 %) but increased seedling length (3.36 cm), primary root length (1.57 cm), primary root dry weight (11.39mg), seedling fresh weight (291.89mg), primary root fresh weight (167.44mg) as well as primary shoot fresh weight (118.23mg). Where, concentration 0.2 mM GA3 improved the important seed quality characteristics like normal seedling (40 %) primary shoot length (3.04 cm) but decreased abnormal seedling (27 %).

Keywords: GA3, germination, *Glycine max*, planting dates, water deficit

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Biomass Partitioning and Gas Exchange Parameters in Different *Musa* Cultivars as Influenced by Natural Shade

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Small coffee growers throughout Latin America intercrop Gros Michel dessert banana and a few other cultivars in small proportions with shaded coffee. We studied the effect of natural shade levels on biomass production and partitioning and gas exchange parameters (photosynthesis (An), stomatal conductance (gs), transpiration rate) to determine if biological performance related to grower cultivar preference. Small corms of 9 Musa cultivars grown for 1–2 months in a nursery were planted into an existing coffee plantation with three levels of natural shade (75 %, 50 %, 25 %) generated by *Erythrina poeppigiana* compared to open sun in Turrialba, Costa Rica (685 masl, 2700 mm precipitation). Total biomass production and partitioning were measured at 5–6 months after planting through destructive harvesting in 6 cultivars. Light response curves were measured using a Li-cor 6400XT.

Plants in 75 %, 50 % and 25 % shade were 62 %, 40 % and 11 % shorter and 52 %, 27 % and 4 % thinner compared with plants in open sun. Dry matter accumulation showed similar patterns. Leaf emission rates in all cultivars were also reduced with increasing shade from 6 days in open sun to 8 days in 75 % shade. The level of shade affected partitioning of biomass where leaves > stem > corm > corm sucker > stem sucker with values of 1.32 > 1.19 > 0.97 > 0.19 > 0.04. Although total biomass declined with increasing shade, a greater portion of the biomass was in the leaves and stem. The accelerated rate of leaf emission and development of the plant also lead to greater biomass in suckers with lower levels of shade. Photosynthesis (*An*) decreased with increasing shade. Cultivars in 75 % shade showed 15 % lower *An* than the cultivars in open sun. Gros michel was the cultivar least affected by shade showing similar values of *An* in open sun and 75 % shade with 18.61 and 18.07 (μmol CO_2 m^{-1} s^{-1}), respectively.

Grower cultivar preference appears to be influenced more by market and consumption preferences than by cultivar shade response parameters. Additional data will be collected, including bunch parameters and ratoon cycle length, as a basis for proposing more productive light management strategies.

Keywords: Agroforestry, banana, coffee, plantain, resource partitioning

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Photosynthesis of three Dessert Banana Cultivars along an Altitudinal Gradient

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Bananas are grown by small holder farmers in agro-forestry systems in a wide range of climatic conditions throughout mid and high altitude zones of Latin America and the Caribbean. However, few studies have measured the photosynthesis of different banana cultivars in these conditions, an effect primarily of temperature on banana photosynthesis (An). In this study the leaf photosynthesis of three cultivars was measured at intermediate (1000 m asl) and high altitude (m asl). Gros Michel (AAA) is the preferred cultivar for national dessert banana markets, but is susceptible to *Fusarium* wilt. The two hybrids FHIA 17 and FHIA 23 (AAAA) are dessert bananas reported to be resistant to *Fusarium* wilt and are potential substitutes in *Fusarium* infested fields. Gas exchange measurements of light and CO_2 response curves on the third leaf of plants were conducted to estimate the parameters of a biochemical model of An (Farquhar *et al.*, 1980) - maximum carboxylation rate (Vcmax), potential light-saturated electron transport rate (Jmax) and day respiration (Rd). The results showed higher rates of An at mid altitude. The estimated parameters Vcmax, Jmax and Rd were dependent on leaf temperature. For the cultivar Gros Michel, Vcmax varied from 145 μmol m^{-2} s^{-1} at 1000 m asl (29°C) to 52 μmol m^{-2} s^{-1} at 1400 masl (23.5°C), while Jmax varied from 153 μmol m^{-2} s^{-1} at intermediate altitude to 79 μmol m^{-2} s^{-1} at high altitude. Values of Vcmax, Jmax and Rd standardised at 25°C also differed between locations suggesting an additional effect of site factors such as soil fertility and water availability. FHIA 17 and FHIA 23 had higher rates of An than Gros Michel. Vcmax and Jmax standardised at 25°C were highly correlated with leaf specific area. The FHIA cultivars with a thicker leaf blade presented higher photosynthesis capacity. Understanding changes in photosynthetic parameters for banana are crucial for modelling long-term photosynthesis and productivity in these agroforestry systems, an important tool for improving their productive and economic viability.

Keywords: Altitude, banana, biochemical model, light, photosynthesis

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Effects of Salt Stress in Rice Assessed by SPAD and a Hyperspectral Sensor

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Abiotic and biotic stresses are perceived to increasingly constrain plant production. Screening methods that allow for early detection and discrimination of stresses may lead to better crop management or intervention strategies. Here, we tested the sensitivity of SPAD and non-imaging spectroradiometer measurements towards early symptoms of salt stress in rice. Salt stress (NaCl) of about 6 dSm^{-1} was induced to four weeks old rice plants (IR 64). For ten days, stressed and non-stressed control plants were monitored with both, a SPAD metre and a non-imaging spectroradiometer with contact probe and integrated light source. Measurements were taken on the two youngest fully developed leaves at daily intervals. SPAD measurements of salt stressed plants tended to be higher than of control plants; thus pointing at a higher chlorophyll concentration per unit leaf area. Also, the complete emergence of the latest fully developed leaf tended to be later in the salt stressed plants. The analysis of the hyperspectral signatures, hence the diagnosis of salt stress has been done by a two step procedure: In the first step a double Weibull model was fitted to the trajectories of the hyperspectral signatures, taken from stressed and unstressed plants. In the second step the resulting parameter vectors were analysed by a discriminant analysis. The combination of two statistical procedures contains a high discriminatory power and was suitable for a significant salt stress classification five days after stress application. Stress symptoms became more obvious in statistical terms as time increased. With respect to the treatment effect the resulting trajectories were significantly different in the small range of the red edge inflection point (REIP), salt stress induced a "red-edge shift". In how far this significant difference determines one specific key parameter for salt stress, and if this parameter is dependant or independent of the simultaneously observed SPAD values still requires further research.

Keywords: Abiotic stress, discriminant analysis, hyperspectral signature, non-imaging spectroradiometer, Weibull model

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Diversity and Variance in Phytohormone Content of Sesame (*Sesamum indicum*)

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The level of a metabolite is affected by a number of factors (availability of precursors, activity of biosynthetic enzymes and transformation to other products), all of which are subject to complex regulation. HPLC system coupled with a triple quardapole mass spectrometer was used to study phytohormone content in sesame. The following questions were addressed: the variation in phytohormone content among sesame accession of different geographical origin, the effect of circadial rhythm, differences among plant organs, and stress-induced changes in phytohormone levels. Most accessions showed similar hormone levels but one accession originating from Japan showed ten time higher salicylic and jasmonic acid levels in leaves and roots. Consistent with this result, the accession was found to produce large activitity of chitinase, which is an important enzyme in plant defense reaction. 75 % of variation in salicylic acid could be explained by chitinase. Plants of this accession were shorter in height, had smaller capsules and produced significantly lower yields. We speculate that the constitutively increased levels of two stress hormones exerted a negative effect on the fitness of the plants.

The effect of circadian rhythm was studied on accession by sampling leaves, stems and roots every 3 hours, but no circadian influence was detected in abscisic acid, salicylic acid, jasmonic acid and indole-3-acetic acid (jasmonic acid and indole-3-acetic acid were below detection limit for most samples). Concentrations of vary in different parts.

The effect of biotic and abiotic stress on phytohormone level were also studied. Among the treatment used, spraying the plants with 2mM $CuCl_2$ significantly increased the concentration of salicylic acid.

Keywords: Circadial rhythm, diversity and variance, phytohormone, *Sesamum indicum*

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Leymus chinensis Overcomes Salt Stress by Increasing Individual Ramet Growth

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Songnen plain is a large natural grassland in Northern China, where most of parts are suffering from salinity and alkalinity. Overgrazing, an additional major threat, accelerates degradation processes in the grassland during the last four decades. *Leymus chinensis* is a dominant rhizome grass and resists to grazing as well as tolerates to salt. However, the adaptation mechanism of *L. chinensis* is largely unknown. A two factorial field experiment was carried out in the natural *L. chinensis* community, combining the addition of mixed salt-alkali solution (NaCl: $NaHCO_3$: Na_2CO_3 = 1:1:1) with clipping (removal 60% of aboveground biomass). Aboveground biomass (AB), plant ramet density, net photosynthesis rates and rhizome sugar content were measured.

Salt and clipping had an interactive effect on AB of *L. chinensis*. Salt addition significantly increased AB under no clipping treatment but under the clipping. The significant increase of AB is due to a high leaf area index and net photosynthesis rates of individual ramets under salt stress, although the total ramet density was significantly decreased. The clipping significantly decreased AB regardless of salt addition probably due to the decrease of rhizome sugar content.

Our results suggest *L. chinensis* can grow well under the salt stress through ramet compensation, which is the decrease of ramet density was compensated by the increase of individual ramet biomass. The dead ramets remove salts to lower soil salt concentration making the live ramets grow better. However, this is probably an unsustainable strategy of *L. chinensis* to cope with salt stress, a long-term field study is needed in the future research.

Keywords: Clipping, *Leymus chinensis*, photosynthesis, salt stress

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Differential Response of some Bread Wheat (*Triticum aestivum* L.) Genotypes on Yield and Yield Components to Terminal Heat Stress under Sudan Conditions

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Due to the high food demand, the expansion of wheat production into the warmer non-traditional areas becomes a necessity in Sudan. Therefore the objective of this study was to assess the genotypic variability and heat tolerance among 15 wheat genotypes under terminal heat stress under Sudan field conditions. Three different sowing dates (S1, S2 and S3) were used to simulate terminal heat stress. A split-plot design with three replications was used to lay out the experiments, for two consecutive winter seasons (2005/06–2006/07), at Shambat (Khartoum, Sudan). Different genetic aspects and heat tolerance parameters were estimated for various measured plant attributes. Results of combined analysis revealed highly significant difference due to sowing dates for most of the investigated traits, with some rare exceptions. There was a significant effect of heat stress on growth and yield of wheat. Heat stress (late sowing=S3) resulted in reduction of many of the studied characters, *e.g.*, dry weight (g), number of spikelets/spike, number of kernels/plant and 100-kernels weight (g), and the maximum reduction (up to 42.3 %,) was observed in yield kg ha^{-1} during the first year. Wide genetic variability was determined among genotypes for the estimated heat tolerance parameters. Genotype $\times$ environment interaction was significant for most of the measured traits. Grain yield kg ha^{-1} was positively correlated with some of its components, where it had a positive and significant association with number of kernels per plant, number of spikelets per spike, number of kernels per spike, and 100-kernels weight (g). Significant positive and negative correlations among yield components were observed. It could be concluded that the induced terminal heat stress during both years was severe enough to cause a reduction in yield of the tested genotypes. The observed significant effect of the interaction between sowing dates and years on yield entails the crucial impact of the onset and duration of winter season on wheat productivity under Sudan conditions. The determined differential variability to terminal heat stress exhibited by genotypes and the estimated correlation among different traits could be exploited in breeding programs for improving and development of new wheat cultivars more adapted to wheat high-temperature non-traditional areas of Sudan.

Keywords: Heat stress, Sudan, wheat genotypes

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Crop biotic stresses (DPG session)

At the Edge of Farmers' Health? Pesticide Use in Intensive Vegetable Production in Three Indian States

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Risks related to the use of pesticides are known and pose a threat to the natural resource base and to the health of users. This study examined pesticide poisoning among 290 cabbage and cauliflower growers in three Indian states to identify factors that influence the occurrence of poisoning incidents. Multinomial logistic regression models were developed to reveal the factors influencing the number of signs and symptoms caused by pesticide exposure and those influencing the spillage of pesticides on the body. About 23 % of respondents reported one to three signs and symptoms of mild to moderate poisoning, and 44 % experienced four to twelve signs and symptoms. Forty percent used extremely hazardous and highly toxic pesticides, 28 % indicated applying more than the recommended dose, and almost 70 % spilled pesticide on their bodies. The multinomial logistic regression models had good fits and were able to correctly predict between 61 % and 77 % of the cases. Results showed that 'farmers' risk awareness', 'location', and 'pesticide spillage' significantly influenced the number of signs and symptoms experienced. 'Risk awareness' was found to be a result of previous poisoning experience rather than a precondition for careful handling. Excluding the variables 'location' and 'pesticide spillage' revealed the significance of the 'application frequency', 'farmers' risk awareness', and 'whether farmers applied pesticides on their own'. 'Whether farmers applied pesticides on their own or not', 'location' and 'application frequency' had a significant influence on pesticide spillage. It is alarming that farmers seem to develop increased risk awareness through trial and error, and often experience negative side effects from this learning method. Any extension approach should therefore emphasise information on negative health effects to increase farmers' risk awareness and note the need to follow correct dosages and appropriate application intervals. The latter two points deserve the attention of research from an ecological and economic point of view to quantify the damage caused to the environment as well as the loss small-scale farmers incur annually through the overuse of pesticides in vegetable production in India.

Keywords: *Brassica*, multinomial logistic regression, pesticide hazard, poisoning

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Indigenous Children's Chlorpyrifos Exposure in Banana and Plantain Hamlets in Talamanca, Costa Rica

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In Costa Rica, chlorpyrifos-treated bags are used to protect banana and plantain fruits from insects and to fulfil product standards.

To evaluate children's exposure to chlorpyrifos in hamlets situated nearby banana and plantain farms in Talamanca, Costa Rica.

The study was performed in three hamlets: in two, chlorpyrifos-treated bags were used in surrounding banana and plantain plantations whereas in the third, an organic village mostly not. In total, 140 children donated a urine sample of which forty on more than one occasion (n=207). TCPy levels were measured as a biomarker for chlorpyrifos exposure. Also environmental samples were taken.

Children from the banana and plantain hamlets had higher TCPy concentrations in urine than children from the organic hamlet, GM=2.6; 2.2 and 1.3 μg/g, respectively. In the plantain hamlet boys had higher concentrations than girls: GM=2.9 versus 1.5 μg/g creatinine, whereas in the other villages levels were similar for both sexes. Children from the banana village were more homogenously exposed than children from the plantain hamlet. In the banana and plantain hamlets, chlorpyrifos was detected in several environmental media, including children's (n=12) hand and foot wash samples. Median estimated values of the Absorbed Daily Dose of children from the banana and plantain village were about five times above the chronic US-EPA established reference doses (RfD). Respectively, 2.5 and 10 % of these children had estimated values above the acute RfD.

Children living nearby plantations that use chlorpyrifos-treated bags are being exposed and at risk for overexposure. Measures are required to reduce this exposure.

Keywords: Banana, biomarkers, children, chlorpyrifos, developing countries, indigenous, plantain, plantations, TCP, urine

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Predicting the Potential Future Geographic Distribution of *Striga* under Climate and Land Use Change

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As parasitic weeds of the genus *Striga* (Orobanchaceae) are a major constraint to agriculture of the semi-arid regions in sub-Saharan Africa, Striga´s actual and future distribution needs to be estimated urgently, in order to better and more efficiently target available *Striga* management strategies. Using innovative GIS-based modelling complemented by greenhouse and field studies, our research aims to better understand the present geographic distribution of *Striga* species and to predict potential future expansion areas of these dangerous weeds. Parameters determining the presence or absence of *Striga* were analysed and available data complemented by new studies on *Striga* ecology and seed bank dynamics gained in green house and field studies at the University of Hohenheim and ICRISAT, Mali.

Based on the present geographic distribution and the factors affecting it, different climate and land use projections have been applied to indicate areas that will be(come) susceptible to *Striga* in future. Climate envelope models have been used to identify areas where climate conditions are expected to change into suitable ranges for the spreading of *Striga* subpopulations from different regions of Africa.

The outputs of this approach will directly support and target crop improvement research and variety (maize, sorghum, pearl millet) dissemination in Striga-affected areas, and provide important decision support tools for technology development and integrated *Striga* management strategies.

The aim of our work presented here is to provide the necessary information to fill in the current knowledge gaps in *Striga* research considering its geographic distribution and the effects of climate change on this distribution patterns.

Keywords: Climate change, parasitic weeds, potential distribution, *Striga*

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Effect of Different Biofumigant Brasicas and Mixed Cropping of Pea and Oat on their Growth and Yield

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A field experiment was set in April 2010 to investigate the effect of deep and shallow ploughed fields mulched with biofumigant brassica in the previous fall. The brassica differed in their levels of glucosinolate/isothiocyanate contents low (*Sinapis alba*), medium (*Raphanus sativus* conv. *oleiformis*) and high (*Brassica juncea*). These were grown from August to October 2009 as cover crops. Sole and mix cropping of pea and oat were studied to study the potential of the brassica crops on weeds, pea diseases and the mixture effects on nitrogen fixation, growth and yield.

In single pea cultures deep ploughed plots had less weeds as compared to shallow ploughed plots. In sole culture of oats and mixed cultures weeds were reduced. Sole pea crop had higher yield in deep ploughed field. In mixed crops pea seed yields were higher than the fifty percent of the sole pea cultures but oat yields were lower. Yields of peas grown in *S. alba* and *R. sativus* mulched plots in deep ploughed fields were somewhat higher. Disease severity data indicates that the brassicas did not differ in their effect on pea root disease. Fungi were identified from infected pea roots among all the *Phoma medicaginis* was dominant followed by *Fusarium* spp., *Mycosphaerella pinodes* and *Ascochyta pisi*. Except *P. medicaginis* there were relatively less pathogens when peas were intercropped with oat than in pea sole crops. At the end of the season plots with single pea had higher nitrogen, followed by mixes of pea and oat.

These initial results indicate that mixed cultures had profitable biomass, yield and nitrogen productions with less weed infestation. The biofumigation treatments had no differential effect on the parameters assessed.

Keywords: Biofumigation, biomass, disease severity, plough, sole and mix cropping, weed, yield

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A Molecular Detection Tool for the Biocontrol Agent *Fusarium oxysporum* F.sp. *strigae,* a Putative Mycoherbicide for *Striga hermonthica,* in Soil

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The parasitic weed *Striga hermonthica* is one of the major constraints to cereal production in Sub-Saharan Africa affecting the livelihood of about 100 million people. *S. hermonthica* significantly affects crop yield of maize, and sorghum, sometimes leading to 100 % crop loss in the field. Biocontrol agents (BCA) of *S. hermonthica* such as the putative, soil-borne mycoherbicide, *Fusarium oxysporum* f.sp. *strigae* (acronym: Foxy 2) have been shown to effectively control *S. hermonthica*. For its application in the field, it is necessary to assess persistence and survival of Foxy 2 in the soil to evaluate if the target BCA is still useful in the preceding growing season and if it potentially induces undesired negative side-effects on the natural, sorghum-associated soil microbial community. As a prerequisite for this required field evaluation, a reliable detection tool needs to be developed to monitor the fate of Foxy 2 in the field. Cultivation-independent, nucleic acid-based molecular methods such as quantitative polymerase chain reaction (qPCR) may be appropriate as this technique has been proven as superior in detecting and monitoring microbes in soils as compared to other conventional, cultivation-dependent procedures such as estimating colony forming units (cfu). In the presented study, a laboratory experiment was performed in which two contrasting tropical soils were inoculated with 4.56×106 microconidia per gram fresh soil and incubated at 28°C for 16 weeks. To assay a potential competitive effect of the natural soil microbial community, one proportion of each soil was sterilized. At defined time intervals, soil samples were obtained from which DNA for qPCR as well as cfu were isolated to determine the fate of Foxy 2 in the soils. Our results showed that Foxy 2 was able to survive and propagate over time in the soils; however, abundance of Foxy 2 was clearly reduced in the unsterilized soils showing a potential competition effect of natural microorganisms. In conclusion, the used molecular detection tool was suited to study, complementary to cultivation-dependent cfu counting, the fate of Foxy 2 under controlled conditions, but may further tested in the presence of sorghum and *S. hermonthica* under natural field conditions.

Keywords: Biological control agents, *Fusarium oxysporum* f.sp. *strigae*, *Striga hermonthica*

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Microarray Analysis of Gene Expression Induced by *Bacillus subtilis* in Tomato Leaves infected with *Phytophthora infestans*

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Bacillus subtilis, the re-isolated cells from the biocontrol agent FZB 24® (Biotechnik GmbH, Berlin, Germany) and their metabolites harvested after 72 hours of culturing, has shown promising results in biological control of late blight caused by *Phytophthora infestans*. To gain a better understanding of the mode of protection, the effect of the bacteria and their metabolites on differential expression of tomato genes in leaf tissue infected with *Phytophthora infestans* were evaluated. Tomato plants were inoculated with the *P. infestans* 24 hours after applying the microbial cells or metabolites on the lower leaf pair. Total RNA was extracted from the upper leaves 12 hours after inoculation. The plants were divided into two groups healthy and diseased plants, which were untreated as well as treated with the microbial cells or metabolites, respectively. Extracted RNA was used for the microarray analysis and the validation of the array results using quantitative real-time PCR. For the healthy plants, the data created from the cell and the metabolite-treated plants showed a minority number of re-regulated genes of 34 and 8, respectively, when compared with the healthy untreated ones. Results from microarray analysis showed that the pathogen changed the expression level of a substantial number of 682 genes from over 9200 genes on the tomato genome array when compared to the healthy plants. Application of cells and metabolites altered the expression levels of 656 and 345 genes, respectively. From those 489 and 299 genes are common between the two comparisons, which might be responsible to the infection. Interestingly, the comparison between cell or metabolite-treated and untreated diseased plants show 26 and 79 differentially expressed genes, respectively. Several genes were identified as up-regulated, including genes involved in plant defense responses, signal transduction, transcriptional regulators, and stress response. Down-regulated genes displayed identity with genes involved in cell regulation process. Differential expression of selected genes was validated by quantitative real-time PCR. Microarray analysis of gene expression showed a stimulation of systemic defense response in tomato plants induced by *B. subtilis* cells and its metabolites against *P. infestans*.

Keywords: *Bacillus subtilis*, gene expression, microarray, *Phytophthora infestans*, plant resistance, systemic protection, tomato

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The Principle of Vector Competence of Western Flower Thrips (*Frankliniella occidentali*) in the Transmission of Tomato Spotted Wilt Virus

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The complex and specific interplay between thrips, tospovirus and their shared host plant, has led to outbreaks of crop disease epidemics of economic and social importance. The exact details of the processes promoting the vector-virus-host interaction and their coordinated evolution, increases our understanding of the general principles involved in pathogen transmission by insects, which can then be exploited to develop sustainable strategies for
controlling the spread of the virus through plant populations. In this study, the model systems *Frankliniella occidentalis* and Tomato spotted wilt virus (TSWV) were used to examine more in detail the influence of TSWV on the *F. occidentalis* vector competence, as well as the contribution of *F. occidentalis* behaviour pattern and sex biasness in promoting vector competence.
Thrips were reared on either infected or uninfected Capsicum annum leaflet throughout their larval stages, and later transferred individually on healthy leaf disks for further experiments.The exposure to TSWV improved the fitness of the WFT in regard to longevity and survival,with mean longevity being higher in exposed thrips compared to unexposed. 15-day mortality test showed low rates of mortality in exposed as opposed to unexposed thrips. The results also showed a reduction in mean daily fecundity as well as lifetime fecundity in the exposed
compared to unexposed on uninfected leaf disks. Choice test towards infected and uninfected host plants showed significantly higher preference of adult WFT to the infected plant over the uninfected. This suggests that the nutritional situation for the developing larvae would be better on the infected plants and is a determinant for the fitness of the adults. The ongoing and future work is envisaged to give a clear understanding into the plant-vector-virus interaction, which is essential for accurate diagnosis and control of the TSWV epidemic,as well as the control of *F. occidentalis* as crop pest.

Keywords: *Capsicum annum*, *Frankliniella occidentalis*, thrips, tomato spotted, tospovirus, vector competence, wilt virus (TSWV)

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Climate Change Effect on Insect Pest: Brown Plant Hopper and Pest Management in Thailand

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Rice is a major food security crop in Thailand as well as in other countries of the Asian region. Thailand is the world's largest exporter of rice; in 2010 9.03 million tons of rice were exported. The most produced strain of rice in Thailand is jasmine rice, which is a higher quality type of rice. However, jasmine has a significantly lower yield than other types of rice, but it normally fetches more than double the price of other strains on the global market. Insect pests are a serious problem in rice production and decrease rice yields. Outbreaks of pests are due to a number of reasons and is symptomatic for unsustainable agricultural practices. Amongst the unsustainable practices are the excessive and indiscriminate pesticide applications that impact upon beneficial organisms through ecological disruptions and resistance of the target pests to the applied pesticide. Furthermore, global warming may affect crop damage caused by insect pest, by changing the degree of synchronisation between pest occurrence and the susceptible stage of crops. This is the case of the brown plant hopper (BPH), *Nilaparvata lugens* Stal is a serious insect pest, especially in tropical Asia on continuously cultivated rice. Both nymphs and adults of BPH damage rice plants through extensive feeding on them. BPH also transmits viruses such as rice ragged stunt (RRSV) and rice grassy stunt (RGSV). Thus, increased levels of BPH occasionally accompany substantial losses of rice crops through virus diseases. There is now clear evidence of resistance development to some of the recently introduced pesticides such as imidacloprid and other groups of chemical use in rice field. Reducing the vulnerability of the rice crop to pest outbreaks entails a holistic management approach and understanding of the key sciences, *viz*. ecology and toxicology. This paper will discuss, how climate change could impact insect pest management practices including brown planthopper management in Thailand.

Keywords: Brown planthopper, global warming, integrated pest management (IPM), rice pest

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Effect of Fungicide Seed Treatment on Control of Cereal Cyst Nematode *Heterodera filipjevi* on Wheat with Different Levels of Genetic Resistance

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This study was carried out to investigate the influence of a fungicide FO EZA 14510 used as a seed coating to determine its efficacy in reducing infection of the sedentary cereal cyst nematode *Heterodera filipjevi* and possible interactions with wheat germplasm having different genetic sources of resistance under controlled condition in ATEAM, Eskisehir, Turkey. The three different susceptible S wheat germplasm (Seri, Bezostaya & Gerek) and three moderately resistant MR wheat germplasm (F130L 1.12/ATTAILA, Katea & Sonmez) were tested at increasing fungicide concentrations of 25 g ai/100 kg seed, 50 g ai/100 kg and 100 g ai/100 kg seeds. The fungicide was applied as standard seed coating used to control damping-off fungi. The MR germplasm gave a significant reduction in nematode reproduction in terms of *H. filipjevi* cyst number per root system when compared to the susceptible S germplasms. A significant reduction in cyst number was observed on the S germplasms Seri (3.8 ± 1.5), Gerek (5.4 ± 2.6) and Bezostaya (6.4 ± 2.0) when the seed was treated with the fungicide. The plant growth parameters were not significantly increased by the seed treatment when compare with control as measured by plant height, shoot weight, root length and root weight. However, the greatest increase in shoot height was detected on the fungicide treated and moderately resistant germplasm. No phytotoxicity symptoms were observed on the plant at any of the fungicide concentrations used. The results demonstrated the presence of an interaction between fungicide and specific types of germplasm and fungicide seems to increase plant resistance to *H. filipjevi* infection by mechanisms still to be identified.

Keywords: Germplasm, pesticide interactions, seed treatment, tolerance

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Symptoms of *Fusarium proliferatum* on Maize Leaves

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Maize (*Zea mays*) is an important food crop and a well-known host of *Fusarium* species. Some of these including *F. proliferatum* are capable of producing large quantities of mycotoxins that are harmful to humans. Different *Fusarium* species have been isolated from maize showing typical rot symptoms at ears or stems. However, no report is available on the symptom development of *Fusarium* spp. on maize leaves, especially for *F. proliferatum* producing fumonisin. Maize plants, cultivar Tassilo, were grown under two different light intensities and durations of 5800–6000 lux, 9 hours per day and 18000–20000 lux, 15 hours per day under climate chamber condition. The plants were inoculated by hand spraying the leaves at BBCH 13–15. Data on disease incidence (*i.e.* the proportion of symptomatic plants within a sampling unit) and re-isolation frequency (*i.e.* the proportion of the leaf tissues colonized by *F. proliferatum*) were collected. For microbial initiation, symptomatic and asymptomatic leaves were incubated on CZID media. Disease incidence of *F. proliferatum* was 40 %. Re-isolation frequency from leaves with symptoms was higher than from asymptomatic leaves, with a colonisation frequency of 100 % and 63 %, respectively. Heavy symptoms of *F. proliferatum* appeared on young leaves emerging from the whorl from 7 days after inoculation. Holes were present in the emerging leaves or folded leaves were rotten. Mild symptoms including white- or brown- round or oval spots were observed on upper leaves. On old leaves, the symptoms appeared later and less severity with brown or yellow lesion ranging from 0.5 to 2.5 cm in length and mostly at the leaf edges. The same symptoms of *F. proliferatum* were also detected in the green house during winter with low light conditions. This indicates that the symptoms of *F. proliferatum* appear on maize leaves under less ideal condition of plant growth.

Keywords: *Fusarium proliferatum*, maize leaves, symptoms

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Effect of Soil Type and Moisture on some Biological Aspects of *Bactrocera invadens*

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The invasive fruit fly (*Bactrocera invadens*) was found in Sudan in 2004 as unknown species introduced into the country. In 2005, the pest was recorded and identified in Sri Lanka and a number of African countries. Recently, *B. invadens* has made a rapid expansion across several states in Sudan. Most of the fruit fly larvae pupate in the soil, but the influence of soil type and soil moisture on *B. invadens* pupal mortality is not known. Soil moisture is considered a major pupal mortality factor on other tropical tephritid species. In Sudan, all orchards are generally irrigated by surface irrigation system. Surface irrigation cause a high humidity in the orchards soil and consume large quantity of water. A laboratory trial was conducted to test the effects of soil type and soil moisture on the pupal survival through a factorial experiment, using three soil types (clay, sand and silt) and five levels of water (0, 5, 10, 15, and 20 ml). Each treatment was replicated three times. Each replicate (a plate, 9 cm in diameter) contain 50 g of soil. Twenty late, third-instars' larvae (reared from guava fruits) were added to each replicate. The three soil types were analysed to determine the pH, EC, soil moisture and organic content, in addition to the classification of the soil type. Also, percentages of emerged and non emerged adults, deformed larvae and that of males and females were calculated. The results revealed highly significant differences between soil types and soil moisture. The results showed that, the soil moisture is an affecting factor on *B. invadens.* The results of this study also indicate that, the surface irrigation applied in orchards is an important factor determining the population density of the fruit fly during the season. The study suggested that, a change of this system of irrigation would be of value in controlling the invasive fruit fly. More investigations are needed on other factors affecting the fruit fly population.

Keywords: *Bactrocera invadens*, moisture, soil type, Sudan

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The Role of Plant Defense Proteins During Early Symbiotic and Pathogenic Infection in Model Legume *Medicago truncatula*

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Legumes are among the most economically important crop families playing a vital role in human and animal diet as excellent sources of protein, vitamins, minerals and other nutrients. Grain legumes including chickpea, pigeon pea, soybean, dry beans, etc, form an extremely essential protein source for millions of poor families in semi-arid and tropical regions of many Asian and African countries. Legumes are unique in establishing rhizobial bacteria association which allows nitrogen fixation, production of protein-rich food and hence able to grow in nitrogen starved soils. Legumes are also capable of establishing symbiotic association with arbuscular mycorrhizal fungi. However, their pathogenic interactions with oomycete root rot pathogens like *Aphanomyces euteiches* often lead to major yield losses worldwide. The infection physiology involves protein-protein interactions between the pathogen and the host plant, where the latter generates symbiotic and pathogenic specific cellular responses. Our research study focuses on the two plant response mechanisms using the model legume *Medicago truncatula*.

We characterised the early host plant response upon infection by symbiotic (*Sino rhizobium meliloti* and *Glomus intraradices*) and pathogenic (*Aphanomyces euteiches*) microorganisms in wild type and transgenic plants lines deficient of a candidate signalling protein MtRac1 involved in host plant defense and symbiosis. Phenotypic comparisons of MtRac1-deficient plant cultures with wild type plants shows significant differences indicating the role of this protein in plant growth. Our results on gene expression analysis via semi-quantitative RT-PCR show significant expression of MtRac1 in wild type plants and transformed vector control cultures upon infection but not in Rac1 deficient cultures. Furthermore, analysis on evaluation of infection profiles, proteomic analysis and mass spectrometry to identify protein patterns activated in the plant cells will confirm the role of initial defense proteins against microbial infections. These results contributes to the development of new practices for control of soil borne pathogens and provides an outlook to investigations on opportunities for disease resistance development in legumes and in plant breeding to capture possibilities of raising crop yield, nutritional quality, limited pesticide use and over all poverty alleviation.

Keywords: *Aphanomyces euteiches*, arbuscular mycorrhizal symbiosis, *Medicago truncatula*, plant defense proteins, *Rhizobia* bacteria symbiosis

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Relative Contribution of Environmental Factors to the Population Dynamics of the Cassava Green Mite

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The producing landscape of Northeast Brazil is dominated by smallholder agriculture. Slash and burn management practices are still used by local farmers to cultivate staple crops such as cassava (*Manihot esculenta*), which is attacked by a variety of pests, including the cassava green mite *Mononychellus tanajoa* (Acari: Tetranychidae). This pest is responsible for high yield losses in Brazil and may be kept in check by naturally occurring predatory mites of family Phytoseiidae. In addition to predatory mites, environmental factors may also contribute to regulate pest populations in the field. We evaluated the population dynamics of *M. tanajoa* and the most abundant predatory mite found in the study region, the generalist phytoseiid *Euseius ho* (Acari: Phytoseiidae), over the cultivation cycle (11 months) of cassava in four farms. In each farm, 10 cassava plants were randomly selected and 6 leaves taken monthly, totaling 60 leaves per farm per month. The number of mites per leaf was recorded and subsequently converted into number of mites per cm^2. Moreover, we determined the relative contribution of biotic (abundance of *E. ho*) and abiotic (rainfall, temperature and relative humidity) environmental factors to the abundance of *M. tanajoa*. The abundance of *M. tanajoa* was high and increased whereas the abundance of *E. ho* was low and remained constant throughout the cultivation cycle of cassava. Hierarchical partitioning analyses revealed that most of the variance for the abundance of *M. tanajoa* was explained by rainfall and relative humidity followed by *E. ho* abundance and temperature. In conclusion, although the generalist predatory mite *E. ho* contributed to regulate populations of the cassava green mite the main mechanisms explaining the abundance of *M. tanajoa* were abiotic environmental factors.

Keywords: Biological control, ecosystem services, pest mites, predatory mite

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Characterisation of Novel Bacteria of the Genus *Pseudomonas* from Dieback affected *Dalbergia sissoo* in Bangladesh

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Dieback of sissoo (*Dalbergia sissoo* Roxb.) is a disastrous disease, which destroyed millions of trees in South Asia. This novel dieback disease is characterised by a combination of symptoms, beginning with wilting of leaves. In later stage leaves become necrotic and fall down as well as smaller twigs do, leading to increasing crown transparency. Loss of branches follows and the disease ends up in the final stage of stagheadedness, where the affected trees loose almost all parts of the canopy. Black spots with gummosis appear on the basis of the trunk and are found up to a height of three to five meters with progressing disease. Various biotic and abiotic factors have been discussed as cause of the dieback disease, but the causal agent(s) could not yet be identified unequivocally. Our recent studies are focused on the molecular detection and characterisation of bacteria of the genus *Pseudomonas*, which are found to be associated with dieback affected sissoo trees from various sites of Bangladesh, including the regions around Dhaka (Mirpur), Tangail, Sirajganj, and Bogra. The bacteria were detected in roots, bark, branches and leaves of dieback affected *Dalbergia sissoo* trees. Phylogenetic analyses based on sequences of 16S rDNA and single copy gene gacA revealed that the isolated bacteria represent strains of a yet unassigned species of *Pseudomonas*. To proof Koch´s postulates, sissoo seedlings were inoculated via various techniques including leaf infiltration and submersing the roots of very young seedlings in suspensions of representative *Pseudomonas* isolates. The symptom development was analysed during a period of culture ranging from one week up to twelve months. To analyse whether the *Pseudomonas* isolates used for inoculation could be identified later in the inoculated plants, bacteria were re-isolated from these plants and characterised by sequencing.

Keywords: Bacteriosis, dieback, shisham, sissoo

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Control of *Phytophthora palmivora* in Organic Cocoa in Southern Vietnam

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Worldwide, *Phytophthora palmivora* is the most important disease of cocoa, causing yield losses of 30 to 90 %. Smallholders, who produce the largest share of cocoa worldwide, often face constraints regarding access to inputs. Botanical sprays or resistant cultivars could help smallholders, because they often do not imply cash expenditures. Therefore the Eco-Cocoa programme (supported by the Swiss NGO Helvetas) in southern Vietnam worked with garlic as botanical spray and tested 83 cocoa clones available at research station level for resistance to *Phytophthora palmivora*.

When pure garlic extract was mixed with carrot agar at concentrations of 0.2 and 0.5 %, no fungal growth at all was observed after inoculation with *P. palmivora*. When the garlic extract concentration in the medium was lower, the effect was weaker, but still significant. In a field trial, cocoa seedlings were first sprayed with garlic extract diluted in water to make a 0.2 % and 0.5 % solution. 36 hours later the seedlings were inoculated with *P. palmivora*. The effect was weak; the differences between the garlic treatments and the check were not significant. However, since the trial was set up in the dry season, development of the fungus was relatively slow.

Due to the encouraging laboratory results, it is suggested to repeat the experiment under conditions closer to the field reality and to test other forms of application like: 1) As a soil drench by spraying the solution on the soil under the cocoa tree to reduce the build-up of the fungal population in the soil; 2) “Spot spray” of a highly concentrated garlic solution on the pods; 3) Mixtures of garlic extract with other botanical agents like neem extract in order to increase the efficiency of the spray.

Of the 83 cocoa clones tested in the resistance trial, 41 clones were rated as highly susceptible, 26 clones were susceptible and 11 clones were moderately susceptible. Only 5 clones received the rating “moderately resistant” and none was rated as resistant. The statistical analysis showed that the test (performed on 15 pods per clone) was not sufficiently sensitive to discern reliably between different degrees of resistance.

Keywords: Cocoa, garlic, *Phytophthora*, resistance to disease

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Assessing the Impact of New Rice for Africa (NERICA) in the Management of African Rice Gall Midge (*Orseolia oryzivora*, Harris and Gagné) in Nigeria

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Rice is one of the staple food crops in Nigeria and is grown in almost all of the Nigerian ecologies. One major cause of low rice yield in Nigeria is depredation by insect pests. African rice gall midge (AfRGM) is the most serious insect pest of lowland/irrigated rice in the recent years. Host plant resistance has been used effectively in the management of related gall midge in Asia. However, screening has shown that most of the *Oryza sativa* cultivars planted in Africa, that are resistant to Asian rice gall midge are susceptible to African rice gall midge, and that *Oryza glaberrima* of African origin that are resistant to African rice gall midge are of low quality. Therefore, hybridisation in order to combine the useful traits of both rice species to resist most biotic stresses has given rise to New Rice for Africa (NERICA). The objective of this study was to evaluate the impact of NERICA in the management of AfRGM in Nigeria.

Field evaluation was conducted at two AfRGM endemic areas in Nigeria (Ogidiga Southeast Nigeria and Edozhigi Northcentral Nigeria) during two successive seasons 2009 and 2010 under rain fed conditions. Thirty rice varieties were used for the experiments: 10 *O. sativa*, 10 *O. glaberrima* and 10 NERICA lines. The fields were laid out as factorial experiments in a RCBD with three replications. Samples for AfRGM infestation were conducted at 42 and 63 days after tillering (DAT) at both locations. For each field sampling, 50 plants were randomly selected to assess the rate of damage by AfRGM (% tiller infestation). All screen house evaluations were conducted at Africa Rice Center, IITA Ibadan.

The results indicated that NERICA lines have significant impact on the management of AfRGM. This was evident for the percentage of tiller infestation reduction recorded among the NERICA lines compared to the *O. sativa* lines. The NERICA has additional advantage of higher grain yield than both *O. sativa* and *O. glaberrima*. On the bases of improved resistance to AfRGM infestation and higher grain yield, it is concluded that NERICA could enhance food security and improve livelihoods in Africa.

Keywords: African rice gall midge management, NERICA, rice yield

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Seed-borne Pathogens Associated with Organic Pea (*Pisum sativum* L.) and Faba Bean (*Vicia faba* L.)

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Pea (21) and Faba bean (11) seed samples were obtained over 2 years from 32 organic farms throughout Germany to investigate the seed borne pathogens in organic seed lots and on the harvested crop. There was considerable variation in two years (2009 and 2010) in seed borne fungi.

In both years most of the samples were infected with pathogens. However, in six of the pea and none of the faba bean seed lots infestations exceeded 10 % in 2009. In 2010 four of the pea seed lots out of 21 had >10 % infestation. In the harvested faba bean crop infection rates exceeded 10 % in 2 cases in 2009 but not in 2010.

Pea infestation rates >10 % were found in 10 out of 21 cases in 2009 and in 5 out of 21 cases in 2010. The most commonly found pathogens on faba bean were *Ascochyta fabae* and *Fusarium* spp. with a mean of 2–3 % in both years. On peas *A. pisi* was dominant both years with 7–14 % infestation. In 2009, *M. pinodes* dominated over *P. medicaginis* in some seedlots but *P. medicaginis* dominated in harvested seed. In contrast in 2010 *M. pinodes* dominated both in the sown and harvested seeds over *P. medicaginis* only in one case *M. pinodes* dominated. Some lots with high seed infestation also had high infestation at harvest. In contrast, a few seed lots had high final infestation, despite healthy seeds. Single and mixed infections with ascochyta blight complex pathogens were found within single seeds. *Fusarium oxysporum, F. solani, F. redolens,* and *F. avenaceum* were identified. Some other fungi including *Alternaria* spp., *Aspergillus* spp., *Penicillium* spp., *Rhizopus* spp., *Trichoderma* spp., *Botrytis* spp., *Sclerotina* spp. and some unknown species were also found with different percentages.

Keywords: Infestation, organic farms, seed lots

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Amylase from *Aspergillus fumigatus* Associated with Deterioration of Rice (*Oryza sativa*)

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In recent years the new potential of using microorganisms as biotechnological sources of industrially relevant enzymes has stimulated renewed interest in the exploration of extracellular enzymatic activity in several microorganisms. Starch degrading enzymes like amylase have received great deal of attention because of their perceived technological significance and economic benefits. In the work reported here *Aspergillus fumigatus* was subcultured on potato dextrose agar slants incubated at 25°C for 72hours. The spores on the surface of the agar medium were dislodged by carefully scraping them with sterile inoculating loop. *A. fumigatus* grew in a medium containing rice. Cultures of the filtrate exhibited amylase activity. Amylase activity was determined using the modified method of Pfueller and Elliot (1959). Maximum enzyme activity was observed on the 5^{th} day of incubation. Amylase activity was determined by measurement of dextrinized power which is a measure of the change in the blue colour of starch-iodine complex due to decrease in the amount of starch. The effect of temperature on the enzyme was examined. The activity of the enzyme was optimum at 35°C and pH 6.0, the enzyme was heat labile losing its activity completely after thirty minutes of heating at 80°C. The cations Al^{3+} and Fe^{3+} stimulated the activity of the amylase. P-chloromercuric benzoate and iodoacetamide inhibited enzyme activity. There was a gradual increase in the amylase activity as substrate concentration increased. Optimum activity was observed at 1 % starch concentration. Amylase activity gradually declined as period of heating increased. Activity was completely lost at 30 minutes.

Keywords: Amylase, *Aspergillus*, deterioration of rice

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Treating Plants with a Cocktail of Beneficial Micro-organisms: Implications for the Biological Management of Sucking Insects

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The control of aphids is normally chemical-based using insecticides from the groups of organophosphates, carbamates and pyrethroids. However, resistance to insecticides, due to their long history of used, joined to aphids' high reproduction rate, has become a serious problem to agriculture and the environment. Because of the known harmful effects of pesticides, there is an increasing use of non-chemical alternatives to reduce risks. The use of endophytic fungi and bacteria represent an interesting alternative to pesticides. The mutualistic endophytes *Fusarium oxysporum* strain 162 (Fo162) and *Rhizobium* etli strain G12 (G12) have been shown to induce systemic resistance against the sucking insect *Aphis gossypii* Glover (Hom., Aphididae) when applied individually. The simultaneous application of both organisms may therefore be a strategy to further increase the biocontrol efficacy. Through a split-root experiment we determined that the simultaneous but spatially-separated inoculation of both endophytes reduced the aphid population in comparison to untreated squash plants. However, the concomitant treatment did not lead to significant synergistic or even additive levels of biocontrol activity with respect to reducing aphid population when compared to individual inoculation. Furthermore, the cocktail consortium caused significant reductions in root colonisation by the beneficial fungal endophyte when both were applied to the same squash plant. The results demonstrate that the mutualistic antagonistic bacterium systemically reduces the activity of the antagonistic fungus without coming into direct contact. The data demonstrated that cocktail type inoculants comprising of different beneficial microorganisms will not always enhance biocontrol efficacy against a pest - in this case *A. gossypii*. This is the first report showing induced resistance mediated by spatially-separated co-inoculation of two beneficials toward *A. gossypii* by means of a split-root system. In conclusion, mutual interactions between beneficial microbes that induce resistance and that are effective individually have to be examined for cross protection activity against one another.

Keywords: Aphid, biocontrol, endophyte, mutualism, rhizobacteria, systemic induced resistance

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Seed Priming with Fungal Endophytes: A New Strategy to Minimize Leafminer Damage in Leguminous Crops

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The occurrence of invasive *Liromyza* sp. in farms across sub-Saharan Africa has continued to devastate vegetable production as well as threaten food security income and livelihoods. Seed treatment with pesticides and or beneficial microbes has become an important aspect of modern IPM systems to provide seedlings with broad protection against pests and diseases. However, prior to utilisation of any biopesticide in pest management, its efficacy and environmental behaviours must be assessed. The present study evaluated the effects of fungal endophyte seed priming on seedling emergence, host plant preference, fitness and performance of two leaf miner species, *Liriomyza sativae* and *L. trifolii*. Overall, there was no effect of endophyte seed priming on seed germination, with endophyte and untreated seeds having a germination rate of 66.7–100 % and 80.0–93.3 %, respectively. Irrespective of leafminer species, the number of eggs laid on ten-day old common bean seedling was not affected by endophyte seed treatment, 48 h after plant infestation. However, seed priming with *Trichoderma asperellum* strain M2RT4 and *Beauveria bassiana* strains S4SU1 and G1LU3 significantly suppressed larval hatching, development and pupation. Consequently, the number of larvae quadrupled in the endophyte free treated plants while those of pupae and adults doubled for the untreated seedlings. As a result, bean seedlings primed with *T. asperellum* or *B. bassiana* were less damaged when compared to the untreated controls. The results of this study suggests that seed priming with mututalistic endophytic fungi can be a useful tool for expanding IPM strategies for effective management of leaf miner damage in leguminous crops.

Keywords: Fungal endophytes, IPM, leafminers, legumes, seed priming

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Laboratory Bioassays of Entomopathogenic Fungi *Ascosphaera apis* against Larvae of Fire Ants (Hymenoptera: Formicidae)

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Chalkbrood is a fungal disease of honey bee larvae caused by *Ascosphaera apis*. The fungus spores enter the larvae by food and germinate in the hind end of the gut around the time when the cells are sealed. Most of the larvae die when they are stretched in the cell. At an apiary there are many ants as a bee predator such as fire ants. They destroy a hive, including eggs, larvae, pupae, and adults that were contaminated by spores of *A. apis*. So the ants were infected with the same disease that the bees had by the similar feeding behaviour. Little attention has been focused on the study of entomogenous fungi in natural environment for ant control. The present study used *A. apis* to control the fire ants. Ants were allowed to walk on filter paper discs, inside Petri dishes, previously impregnated with 1 ml of a conidia suspension 1×10^6 conidia ml^{-1} at 26°C maintained at 75 % RH and transferred to sterile Petri dishes, maintained at 26°C, 80 % RH, 24 h dark. Mortality was evaluated 7 days after application, the dead larvae were keep in Petri dishes in moist-chambers. The results showed some pathogenic effects on the ant. Mortality due to fungal infection were 30 %, the LT50 values were 3.52. This is the first report of the pathogenic effect of entomopathogenic fungi on fire ants. However, studies of the efficiency of this fungus against ant in the field are required before it can be used for ant management in practice.

Keywords: *Ascosphaera apis*, chalkbrood, entomopathogenic fungi, fire ant, honey bee

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Evaluation of some Promising Wheat Lines for their Resistance to Prevailing Rust Races in Sudan

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Wheat is the second most important cereal crop in Sudan. Wheat stem (including Ug99) and leaf rusts are the main diseases of wheat in New Halfa area and occasionally in Gezira scheme. Resistant varieties are the most efficient measure for the control of the disease. Bread and durum wheat lines from national and advanced yield trials of the breeding programme together with some Ug99 promising lines were field-assessed for their reaction to stem and leaf rusts at New Halfa Research Station Farm in season 2010/2011. The materials were grown under mist irrigation and were artificially inoculated. Each entry of the materials was sown on one metre long. Irrigation was done every 10-14 days and 2N of nitrogen fertiliser was added in form of Urea after the first irrigation. Other cultural practices were carried out according to the Agricultural Research Corporation Recommendation. The occurrence of the wheat leaf rust was rare; therefore the evaluation for stem rust is presented. Forty (31%) of the tested lines showed RMR reaction, 81 lines (63%) had MSS reaction (10MSS-80MSS) while the S reaction (60S-70S) was recorded for 7 (6%) lines. The results indicate that the breeding programme accumulated considerable number of resistance lines that could be recommended for commercial production to replace the current susceptible cultivars.

Keywords: New Halfa, rust, stem, Sudan, wheat

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Effect of the Entomopathogenic Fungus *Paceilomyces farinosus* on the Reproductive Potential of Poplar Leaf Beetle *Melasoma populi*

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A local strain of *Paceilomyces farinosus* (isolated from infected sunn insects *Eurygaster integriceps* Put. in Duhok region) was obtained from the Mycology bank/ Plant Protection Dept./ School of Plant Production/ faculty of Agriculture and Forestry/ Duhok University, under the No. PEG-12. Fungus was grown on Potato Dextrose Agar (PDA) for 6–7 days at 25 $\pm$ 1°C . The concentration of fungal suspension was diluted to (10^8) spore ml^{-1}. Spore concentration was determined by hemocytometer.
The effect of the *Entomopathogenic fungus* and *Paceilomyces farinosus* on the reproductive potential of female survivors, egg viability and total egg production of poplar leaf beetle *Melasoma populi* L. was investigated under laboratory conditions. Prepupae, pupae and newly emerged adults were treated with spore suspension of *P. farinosus* (1×10^8 conidia ml^{-1}). Another group of adults were reared on sprayed poplar leaves with a same concentration of conidial suspension. Egg production and hatching percentage were monitored daily over a 7- week period. Overall reproductive capacity (mean no eggs per female survived from fungus inoculums) were significantly lower as compared to the control. The total number of eggs per surviving female were 85.50, 149.50, 123.43 and 280.24 eggs for pre-pupa, pupa, adult and leaves treated, respectively, as compared to 299.75 in the control after fourth week . Pre-oviposition, ovipostion, post-oviposition and the longevity of females and males were shorter in treated individuals compared to the control. The lowest hatching percentage was 75.12 % in eggs deposited by adult feed on treated leaves as compared to 98.42 % in the control.
The mortality of different stages was recorded 12 days after spraying with spore suspension. The data proved that *P. farinosus* have an effect on the different stages of *M. populi* particularly when sprayed on adults; 39.13 and 43.63% mortality was observed after 12 days when directly sprayed or reared on sprayed poplar leaves, respectively.

Keywords: *Entomopathogenic fungi*, reproductive potential, *Melasoma populi*, *Paceilomyces farinosus*

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The Efficiency of Using Different *Trichogramma* Species on the African Bollworm (*Helicoverpa armigera*) Eggs

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Egg parasitoid *Trichogramma* (Hymenoptera, Trichogrammatidae) are extremely tiny wasps. Their females seek out and parasitize host eggs of noxious lepidopterous insect pests such as the African bollworm (ABW), *Helicoverpa armigera*. The recent study aimed at measuring the egg parasitism, emergence rate and female ratio for 5 species per strains of *Trichogramma* (*T. bourarachae* EG 02, *T. bourarachae* KE 99, *T. nerudai* PT 93, *T. piceum* MD 91 and *T. turkestanica* PT 93) at different holding temperatures, with the objective to evaluate the efficiency of using this beneficial to combat infestation of the bollworm both on edible and non-edible crops in Sudan and other countries with similar environmental conditions. The experiments were conducted in two separate temperatures (25°C and 30°C), where *H. armigera* egg-card (containing 60–70 eggs) was exposed to a fertile female of *Trichogramma* sp., each experiment consists of 18–20 females. The average of parasitized eggs, emerging adults, emergence rate and percentage female per female were determined. The results showed clearly that all *Trichogramma* species accepted ABW eggs as a host, but they varied greatly in their egg laying capacity. The emergence rate ranged from 1.12 to 1.55 at 25°C and 1.09 to 1.56 at 30°C. The percentage female ranged from 76 % to 91 % at 25°C and 70 % to 86 % at 30°C. *T. piceum* showed the highest fertility at 25°C and 30°C (91 % and 86 %, respectively) and lower emergence rate (1.16 and 1.09, respectively) compared with other *Trichogramma* tested. The highest emergence rate was obtained from *T. turkestanica* (1.55 and 1.56) at 25°C and 30°C, respectively compared with other *Trichogramma* spp. tested. *T. bourarachae* (KE 99) showed higher emergence rate and percentage female compared with *T. bourarachae* (EG 02).

Keywords: Egg parasitism, emergence rate and percentage female, *Helicoverpa* spp., temperature, *Trichogramma*

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Establishment and Parasitism Efficiency of *Trichogramma principium* on *Helicoverpa armigera* Attacking four Sudanese Cotton Cultivars

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This study was conducted at the Gezira Research Station farm during 2010/11 season to verify establishment and parasitism efficiency of *Trichogramma principium* (Hymenoptera: Trichogrammatidae) in eggs of *Helicoverpa armigera* (Lepidoptera: Noctuidae) attacking the Sudanese cotton cultivars 'Barac 67B', 'Hamid', 'Burhan' and 'Abdin'. *Trichogramma* was acquired from the Rearing Unit, ARC, at preimaginal (prepupal) stage, in eggs of the rice moth Corcyra cephalonica (Lepidoptera: Pyralidae). One release was done on each of Barac and Hamid and two on each of Abdin and Burhan, at 24000 parasitoids per fed, 7×7 m distance between release points and 14 day intervals. Evaluation was done between treated plots with *Trichogramma* versus untreated. Observations included the percentage (%) of emerged parasitoids, % of parasitism and numbers of larvae /100 plants. At the first release, the % of emerged parasitoids ranged between 71 % as in Barac 67B and 86.4 % as in Hamid; the cultivars' average ranged between 60.5 % and 94.8 % and the overall average was 79.2 %. The % of parasitized *H. armigera* eggs ranged between 60 % and 22.2 %. At the second release, the % of emerged adults ranged between 73.2 % as in Burhan and 82.1 % as in Abdin; the cultivars average ranged between 46.6 and 96.7 % and the overall average was 77.7 %. The % of parasitized *H. armigera* eggs ranged between 77.7 % and 22.2 %. The high level of parasitoid emergence declares a good viability of the released material. The levels of parasitism reported were quite acceptable for the first occurrence of the parasitoid in this new cotton agroecosysytem. A positive signal of migration from treated to untreated plots was observed through parasitized *H. armigera* eggs detected in the latter plots. The numbers of *H. armigera* larvae was negligible in both treatments. Accordingly, for proving potential capacity of establishment and parasitism efficiency against *H. armigera, T. principium* is strongly recommended for use on Sudanese cotton cultivars.

Keywords: *Helicoverpa amigera*, Sudanese cotton cultivars, *Trichogramma principium*

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Systemical Effects of Salicylic Acid, Methyl Jasmonate and a Mutualistic Fungal Entophyte on Homoptera Pests in the Phyllosphere of Summer Squash

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In the past it has been shown that *Fusarium oxysporum* strain 162 (FO162) is a reliable inducer of systemic resistance and further for lack-of-attraction effects on parasitic nematodes. Therefore the understanding of the underlying mode-of-action and the further studies on the potential usage can help to improve its adoption as a cheap to produce biocontrol agent especially for tropical regions. In the current study similarities were examined between the fungal actions with Systemic Acquired Resistance (SAR) and Induced Systemic Resistance (ISR). The FO162, Salicylic Acid (SA) as trigger for SAR and Methyl Jasmonate (MJ) as trigger of ISR were tested for systemic based control activity on the aphid *Aphis gossypii* and on the whitefly *Trialeurodes vaporariorum*. Drench applications of the fungus or the chemical inducers resulted in a reduction of aphid, with the strongest reduction following the MJ treatment. However, a second replicate of the experiment showed no significant differences between treatments, although a reduction of the number of insects on plants treated with MJ showed the same tendency. A possible resistance against whitefly was tested in a choice experiment based on the number of adults that settled on the aerial parts of squash plants. Whiteflies were more attracted to untreated plants, whereas the lowest number of insects was found on MJ and FO162 treated. The root weight was significantly reduced on plants treated with MJ compared to the other treatments, but the shoot/root ratio was not affected by any of the treatments. The outcomes of this study elucidate that the effects of FO162 are comparable to those exerted by induced systemic resistance elicitors and although MJ showed to have the highest effectiveness against *A. gossyppii* or *T. vaporariorum*, it affects plant growth and development. A HPLC profile from squash plant parts show similarities between FO162 and the SA induced SAR pathway.

Keywords: *Fusarium oxysporum*, methyl jasmonate, mutualistic endophyte, salicylic acid, systemic resistance

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Influence of Milled Rice Packing Methods on Radio Frequency Heat Distribution in Controlling *Aspergillus flavus* and their Cooking Qualities

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This study aimed to determine the uniformity of heat distributed in different milled rice packages after various radio frequency heat treatments . The responses from the samples in controlling a contamination of *Aspergillus flavus* by heat distribution from an electromagnetic field were investigated. Milled rice var. KDML 105 with 14 percent initial moisture content was used. Samples were inoculated with *A. flavus* at a concentration of 10^6 spores per ml and incubated for 7 days. Three different loading densities were packed and evaluated: (1) vacuum full loaded, (2) non vacuum full loaded and (3) 85% loose loaded. The samples were exposed to radio frequency (RF) heat treatments at an operating frequency of 27.12 MHz with temperatures of 80, 85 and 90°C for 1, and 3 minutes. The heat distribution was taken by infrared cameras, kernel moisture content, degree of remained *A. flavus* infection, amount of aflatoxin, amylose content and cooking qualities were determined. It was found that packing methods affected the distribution of heat significantly. The packing type 1 showed to be the most effective in heat distribution which resulted to a significantly decreasing *A. flavus* infection. The RF treatment at 90°C for 3 minutes duration was the best treatment, the fungus remained was 0.64 %, aflatoxin decreased significantly from 6.68 to 2.8 ppb. The moisture content of all samples decreased with no significant differences. The cooking qualities changed: the gel consistency decreased, the percentage of amylase increased, and the elongation ratio of the rice kernel increased also. Including the changes in their viscosities: the rice's final viscosity, setback value and pasting temperature value increased, in contrast its peak viscosity and breakdown value decreased. The texture of cooked rice increased in hardness and cohesiveness but decreased in adhesiveness. Thus, vacuum packing with RF heat treatment can control *A. flavus* and aflatoxin formation effectively with positive changes in their cooking qualities.

Keywords: *Aspergillus flavus*, cooking qualities, milled rice, packaging, radio frequency

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Physiological Almond Development Associated with Preharvest Aflatoxin Contamination

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Presence of aflatoxin in food causes acute and chronic health effects in humans, ranging from immune-system suppression to growth retardation which can cause liver disease and/or cancer. *Aspergillus flavus* and *A. parasiticus* are the most important causal agents of aflatoxin contamination in almonds, causing considerable economic losses for the almond industry in California. During the month of August 2010, after the almond hull splits, weekly samplings of Nonpareil almonds were performed. Almond kernel moisture content was measured for each sampling time as followed: 1 st 35.26 %, 2nd 31.49 %, 3rd 19.49 % and 4 th 3.06 %. In order to evaluate the most susceptible almond humidity stage for aflatoxin contamination, three highly toxigenic *Aspergillus* strains, *A. flavus* "S-strain" (3G39), *A. flavus* "L-strain" (A224) and *A. parasiticus* (P194) were inoculated (50μl, 5×10^4 ml per spores) on the almond hull and the peeled almond kernel. After 30 days incubation at 30 ^{o}C, aflatoxin content was extracted and concentrations were quantified with High Pressure Liquid Chromatography (HPLC) analyses. Inoculated almonds with and without hull and the highest moisture content (35.26 %) had the highest incidence of aflatoxin, whereas the almonds with the lowest moisture content had the lowest aflatoxin. The highest concentration 583 ng g^{-1} of B1 aflatoxin was measured in kernels inoculated with the *A. flavus* S-strain and gradually decreased to 4.7 ng g^{-1} aflatoxin at the last tested stage. The aflatoxin concentrations of nuts inoculated with an S-strain were positively correlated with the moisture content of the nuts (r=0.84, $p < 0.001$). The results demonstrate that the first days after the hull split, almonds show the highest susceptibility to infection by *A. flavus* and *A. parasiticus* and the susceptibility decreases along with the moisture content of the nuts. Fortunately, the California almond industry has taken a number of measures that reduce preharvest and postharvest aflatoxin contamination. These measures include: 1) Good agricultural practices like insect pest management and product handling; 2) Drying the nuts to a safe moisture content (3–6 %); and 3) Sorting of insect damaged nuts.

Keywords: Aflatoxin, *Aspergillus* spp., moisture content, nut crop

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Side events

Resilence, collapse, reorganisation

Lake Naivasha: Plants, People & Politics

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Lake Naivasha has been globally famous for over five decades because of its Plants - but not the same species. It was initially renowned as 'one of the top 10 bird-watching sites in the world' - hundreds of bird species and tens of thousands of individuals, all sustained by a species-rich plant community in distinct segments of the 'drawdown zone', from the *Acacia* woodlands at the top end and the submerged plant beds at 4 m depth at the bottom end.

All the native submerged and floating-leaved aquatic plant species, and those two lower zones of the drawdown, were removed from the ecosystem by the first effect of People. The commercial fishery was 'improved' in the early 1970s by the deliberate introduction of the Louisiana crayfish. At the time, nobody realised how destructive of the native plant (and animal) species this alien would be. People, through our global transport mechanisms further changed the Naivasha landscape with alien plant invaders - particularly water hyacinth which arrived in 1989 and filled the empty floating plant niche.

The plant for which Lake Naivasha is now world famous – the rose – has been increasingly grown throughout the past 3 decades. Its successful cultivation - for sale to Europe - required irrigation water and labour. Over abstraction of water (including by other demands besides rose cultivation which have grown over the same time), together with a 5-fold increase in the human population, have effectively destroyed the remaining native aquatic plant - papyrus. These dramatic ecological changes have occurred with minimal Political influence - locally, nationally, or internationally - until 2010, despite an adequate legal framework built up by the 1999 Environment Act and the 2002 Water Act. All that changed, because 2009–10 saw the lake level reach the lowest it had reached for 100 years as a consequence of a regional drought whose impact came on top of the over-abstraction. This stimulated major Political initiatives. The presentation will review the current intiatives in the light of the past events and seek to predict their likely impacts upon and probably benefits for, the lake and its people.

Keywords: Lake Naivasha

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Emerging Economic and Social Upgrading in the Kenyan Cut Flower Global Production Network

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Satisfying the ever-demanding tastes of global consumers has led supermarkets to source products from farms scattered across the globe. Today global production networks carrying fresh cut flowers are amongst some of the defining characteristics of production spaces, particularly in developing countries where such networks can and/or do provide important opportunities for economic and social upgrading. Upgrading is the shift to value added activities in production, to expand technology, knowledge and skills, and to intensify the gains captured from participating in global production networks. The process by which economic actors (firms and workers) evolve from low value to comparatively high value activities in global production networks can be described as economic upgrading. On the other hand, when there is an improvement in the rights and entitlements of workers that lead to an enhancement of their working conditions, then the process of social upgrading can be seen to have been set in motion.A key challenge to promoting decent work in global production networks is how to improve the position of both firms and workers. The export of cut flowers in Kenya has expanded exponentially in the last two decades. The expansion of global production in labour intensive industries has been an important source of employment generation. This has lead to an expansion of paid work in the horticultural sector, whose labour force is not only predominantly female, but is often temporary, low paid, informal and insecure (*i.e.* vulnerable). This presentation attempts a preliminary analysis on the emerging opportunities and challenges for promoting economic and social upgrading within the Kenyan cut flower global production network.

Keywords: Cut flowers, economic and social upgrading, global production networks

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Contested Riparian Land at Lake Naivasha – A Historical Perspective

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The riparian zone of water bodies – ecologically the zone between the high and low water mark and the terrestrial land which is strongly influenced by water availability – is considered to be a an area of unique biodiversity which delivers manifold ecosystem services. The management and protection this zone in Kenya falls within the jurisdiction of various government bodies. At Lake Naivasha the riparian zone is highly contested as it serves as a resource for various stake holders, such as land owners, horticultural industries, small scale farmers, pastoralists, national and international conservationist, tourist sector and the general public. With the recent launched of the "Imarisha Naivasha Programme", which is headed by the Prime Ministers Office and supported by International Sustainability Unit of the Prince's Charities, the controversial questions of demarcation, access and use of the riparian zone is back on the agenda.

A distinctive feature in the management of the riparian zone at Lake Nivasha is an agreement that was drawn during colonial time between the Kenyan Colonial Government and the Lake Naivasha Riparian Land Owner Association (LNROA). This agreement stipulated in 1932 how land below the 1906 water level should be managed and used. Based on the analysis of documents and maps from the Kenyan National Archive in Nairobi, this paper seeks to show how riparian land was managed and used during the colonial era, how the agreement between white settlers and the colonial government was negotiated. The historical perspective tries to enhance the understanding of current conflicts around the riparian zone.

Keywords: Historical perspective, lake Naivasha, ripartian land

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This Is Just a Place to Work – Understanding Life among Migrants at Lake Naivasha

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Lake Naivasha is a main destination for labour migration in Kenya. The massive cut flower and horticultural industry sustained by the fresh water lake as well as the geothermal power plant and the business opportunities in the region promise jobs for people from all over the country. As a result, the settlements around the lake have been growing for the past forty years, yet few people decide to settle there ultimately. In the public, the perception of the flower industry is ambivalent. On the one hand, it is of great importance for the Kenyan export sector and therefore believed to bring economic development to the country. The "Western" consumers also believe to help the development of social standards in the industry through buying fair-trade-certified flowers. On the other hand, the working conditions on the plantations and the living conditions in Naivasha are often criticised in the media as well as in academic and NGO-publications.

The work in and life around the flower farms are, beyond this bigger discussion, a reality for the people in Naivasha. My research aims at understanding how the workers and other residents make sense of their life and work in a place which is not their home. Which expectations do they have and which goals do they want to achieve in their lives? Why do they decide to come to Naivasha and even stay for many years, regardless of the unfavourable conditions? How do they perceive and interpret their actual situation and cope with the difficulties they face?

Keywords: Flower industry, lake Naivasha, migration, understanding of life

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Mediated Immediacy – Safari Tourism in Kenya and the Making of an Authentic Experience of African Nature

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Since years Kenya is a very popular tourist destination. Many European tourists spend their holidays on safari: With buses in groups of around 15 people they tour the country to visit different national parks and to observe the "big five" and the scenic nature. Even if some of the tourists arrive on the African continent for the first time, they have very clear perceptions of "Africa" in mind. One of the most common narratives is the one that Kenya – and often Africa – is closer to nature, while Europe is perceived to be more cultural. The travellers come to see and, more important, to experience the authentic, wild, wide, natural, and intact environment. These images are not new. They have a very long tradition in the European way of conceptualising Africa. Very important in the history of these images are the colonial novels, which were popular at the beginning of the 20th century and some of them are still widely read.
Travelling from one place to the next, the tourists see the whole of Kenya through the window of the bus and feel that they are experiencing the "real Africa". Among the places they visit on their trip is also the Lake Naivasha region, although apart from the national parks, Naivasha is a place mainly occupied by the flower industry. The project zones is on tourists' expectations and anticipations of an immediate experience of Africa's wilderness, and explores how this direct experience always requires an intermediary agent that mediates the desired immediacy. A key metaphor for this mediation process are the buses built for tourists to traverse the landscape: Crossing the country while sitting in a bus, the windows of the bus constitute the frame for observing the beautiful nature of which the tourists like to be part, and simultaneously assures them of being protected against the dangers they associate with travelling in Africa. Based on research among tourists as well as among tourist guides, hotel managers, and others involved in Safari tourism at Lake Naivasha, the project explores the different institutions and brokers involved in the business of providing immediate access to Africa's wilderness.

Keywords: Mediation, nature, safari, tourism

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The Lake Naivasha Sustainability Project: An Ecosystem Health Approach

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The Lake Naivasha Sustainability Project is an interdisciplinary and action oriented research project whose aim is to have all stakeholders within the basin participate in addressing the ecosystem health challenges they are facing as consumers and guardians of resources within the watershed. The project adopts a transdisciplinary approach to create a model of ecosystem health that will lead to the continual improvement of the Lake Naivasha basin ecosystem for human health and well-being. In the creation of this model, the project encompasses objectives in the strategic areas of governance, ecosystem structure and function, eco-toxicology, and social economic and medical aspects of community health. The research strategy lies in an interdisciplinary approach wherein the human, environment and human health are evaluated in an ecosystems approach. The specific objectives are: (1) Improving the representation of stakeholders and their decisions in the sustainable management of water resources and understanding the full range of options between the end points of catastrophic human-induced system degradation and ecosystem health; (2) A water balance to assess water supplies and demands; (3) An understanding of the sources, amounts and pathways of environmental pollutants and contaminants for risk mitigation (including determining physicochemical drivers of the ecological status of the lake like the source, production and fate of pollutants, contaminants, harmful bacteria and algal blooms, and determining exposure risks to residents); and (4) An assessment of the environmental pollutant and contaminant exposure risk to residents and workers, particularly vulnerable groups such as women and children, related to socioeconomic activities within the Lake Naivasha basin (including determining socioeconomic characteristics of the basin communities, assessing the general health status of residents and their risk of exposure to contaminants and water-borne diseases). Thus the project has been designed to engage concerns of key stakeholders into the research and for the research findings to be availed to a wide spectrum of interested stakeholders. The Lake Naivasha Ecosystem Health Research Team will present the research outline and criteria of success for this incredibly valuable lake basin and catchment community.

Keywords: Ecosystem health, human health, lake Naivasha, sustainability

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Using Agent-based Modelling to Depict the Processes Leading to Basin Closure in the Naivasha Basin, Kenya

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In many places in the world increasing water demands have led to the development of infrastructure for freshwater storage and irrigation. Especially in water-scarce regions this has led to growing concerns about basin closure. These concerns ask for a structured approach for analysing the occurrence of basin closure in order to facilitate sustainable responses. A spatially-explicit multi-agent simulation (MAS) approach is applied for depicting the occurrence of basin closure by representing the mutual relationship between water availability and water use. The model is developed within the framework of the Earth Observation- and Integrated Assessment (EOIA) project at ITC, the Netherlands. This project is concerned with the governance of Lake Naivasha, Kenya. In cases of basin closure the effects of over-development are most severe for downstream parts of basins. In the case of the Naivasha basin these include both economic and ecological effects. In the proposed model agents represent water users that anticipate and respond to local water availability, based on information that they obtain from their direct local environment. Modelling the dynamics of water use and water availability yields patterns of the distribution of water use and availability over space and time. Model outcomes are analysed and reflected upon by using a range of spatially-distributed data sets, including both natural and socioeconomic indicators. Activities undertaken by agents (land use and management that relates to their livelihoods) are affected by water availability in distinct but connected local water resources such as reservoirs and streams. Remotely-sensed data are used as a source of information and analysing a time series of such data assists in selecting geographical locations for which deeper analysis of the relevant processes is needed. Such analysis may include conducting surveys and interviews with local resource users. Land use classifications that are based on remotely-sensed data offers an opportunity for validation of simulation outcomes for land use, which is the main determinant of water abstraction for irrigation in the proposed modelling approach. This study shows that MAS is a promising approach to supporting water governance and can assist in increasing the understanding of the occurrence of basin closure.

Keywords: Multi-agent simulation

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Options for Improving the Design and Enforcement of Water Institutions in Lake Naivasha Basin, Kenya

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Three broad categories of policy prescriptions have been advocated for towards management of water resources: regulative instruments, economic/market based instruments and cooperative/suasive strategies, forming a "tripod". These broad categories of instruments have been implemented in different forms such as water permits and water pricing as institutions for creating incentives for sustainable and efficient water abstraction and use. However, despite these instruments having been implemented in the Lake Naivasha basin illegal water abstraction is ubiquitous, compromising efficiency and sustainability. By assessing the existence and strength of the above "tripod" in the Lake Naivasha basin, the current paper seeks to answer two key questions: a) what institutional improvements would be feasible in the Lake Naivasha basin, and what effectiveness regarding sustainable water use can be expected from these feasible improvements, and b) given the volatile natural conditions regarding water supply in the Lake Naivasha Basin, what limits do institutional solutions face? Results indicate that the current dismal institutional performance has been caused by a number of conditions relating to weak public administration, ineffectiveness of the current water rights and water pricing system and weak water resource users associations. These, coupled with high transaction costs, lack of incentives and capacity of the state body to implement the rules creates an environment that is not conducive for monitoring and enforcement of institutions. The paper draws imperative policy implications for enhancing water resources management through filling the existing gaps on each of the elements of the tripod. These point towards water rights reform, responsibility sharing between the state and Water Resources Users Associations (WRUAs)and review on the design of the existing water institutions.

Keywords: Enforcement, institutions, lake basin, water rights

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Remote Sensing Based Analysis of Spatio-temporal Vegetation Patterns in South African Rangeland at Different Scales

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Semi-arid grassland and savannah systems in South Africa are vastly used for livestock farming. Thereby, the composition of vegetation, its structure and primary production are strongly influenced by two major factors: precipitation and livestock management practices which typically vary in space and time.

Our project "Vulnerability and Resilience of Rangeland Vegetation as Affected by Livestock Management, Soils and Climate" (subproject A3 of DFG FG 1501) explores the specific influence of climate, soil and management practices on biomass production and resilience of savannah and grassland systems in South Africa. The assessment of resilience makes use of certain vegetation indicators and is based on repeated field measurements distributed along local gradients of grazing intensity in three different livestock management systems. Our data supports earlier findings that the influence of grazing and climate varies along spatio-temporal scales, thus posing a challenge to the interpretation of ground measurements restricted to scattered plots. We hypothesise, that time series of high resolution satellite imagery (RapidEye) help to overcome problems of ground truth data acquisition and interpretation. Within our ongoing work we explore time and spatial scale dependent patterns of heterogeneity of spectral reflectance as induced by the dynamics of vegetation. We specifically investigate three spatial and categorical scales: a) within-fenced-field-scale, b) within-farm-scale, and c) regional scale comprising several farms of differing types of management systems. Spatial and multivariate statistics on several measures of the vegetation signal are applied to answer the following questions: (1) How does the spectral response of vegetation differ between and within areas of the three defined scales? (2) To which extent do observed patterns of heterogeneity allow for a spatial generalisation of vegetation's response as established in field measurements? (3) How are the observed patterns related to characteristics of climate, soil and management and their spatial and temporal patterns?

The presentation will demonstrate the potential of a remote sensing methodology for exploring scale dependent vegetation patterns and for supporting generalisations from scattered plot measurements to larger scale systems understanding.

Keywords: Grassland, heterogeneity, remote sensing, resilience, scale, South Africa, time series

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Is Degradation of South African Grasslands Related to Temporal Variability or Spatial Autocorrelation of Vegetation Parameters?

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In drylands, ecosystem shifts to highly unfavourable states are a common reason for land degradation with large implications for local livelihoods. The resilience of grasslands to system shifts is the result of complex interactions between human management and environmental factors. In South African semiarid grassland systems, degradation processes are mostly due to feedback mechanisms between grazing, vegetation structure, and soil characteristics. Changes in vegetation structure as affected by the intensity of grazing are recordable as dominance shifts in species composition and plant functional types. However, these directional changes are overlain by fluctuations in species composition related to stochastic rainfall. This makes it particularly difficult to identify changes in system resilience. Recent modelling studies suggest that a loss of resilience is coupled to an increased amplitude in the temporal variability, and to an increased spatial autocorrelation of vegetation performance. To analyse a real-world example, high-resolution remote sensing data are a promising tool. In our study, we perform a combined analysis of data on the intra-seasonal variability and spatial heterogeneity of vegetation indices derived from broadband RapidEye™ data, together with data on vegetation composition and topsoil characteristics.

Our case study regions are situated in South Africa's Free State province. We selected pastures in two tenure systems (communal and commercial) with different intensities and frequencies of grazing. On permanent plots located on grazed pastures and within livestock exclosures, we recorded vegetation composition and surface characteristics. Topsoil samples were taken on all plots and analysed for physical and chemical parameters. For plot pixels and neighbouring cells, vegetation proxies were derived using RapidEye™ time series. We used multivariate statistics (Canonical Correspondence Analysis) and General Linear Models to assess if vegetation composition on intensively grazed pastures was connected to an increased intra-seasonal variability and spatial correlation of vegetation proxies. We will present first results from these analyses, and discuss how useful information about the temporal variability and spatial autocorrelation of vegetation parameters is to indicate relative changes of resilience in a real-world system.

Keywords: Rangeland ecology, remote sensing, resilience, threshold indicator

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Conservancies and Conflict: Perspectives on Pastoral Borderlands in East Pokot, Kenya

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Community based wildlife conservancies in Africa are often portrayed as participative and adaptive solutions to prevent ecological degradation and inter-community tensions. They presumably conserve biodiversity, create a natural buffer between hostile groups and by sharing the revenues from tourism, enable sustained peace building processes in formerly contested terrains. A growing number of globally acting agencies and donors support and encourage local communities in establishing their own conservancy, particularly among pastoralists in arid and semi arid areas. The Baringo/East Pokot area in Kenya, stretching from Lake Baringo on the floor of the Great Rift Valley up to the edge of the Laikipia Plateau, has seen the planning and establishment of several community-based conservancies in the recent past. This presentation will concentrate on two of them, one recently established, the other still in the process of negotiation. Located in contested borderlands between the Pokot and neighbouring pastoralist groups, both conservancies need to function as catalysts for inter-ethnic conflict resolution to ensure their long-term success in wildlife conservation and economic viability. Ongoing ethnographic research in the area, however, reveals tremendous difficulties and challenges: Persistent demographic growth, scarce pastures, the privatisation of communal rangelands and unpredictable climate lead to serious controversies over resources that are habitually resolved with the use of modern firearms. Embedded in the national trend of ethnicizing access to resources and politicizing ethnic boundaries, the (planned) conservancies are highly fragile constructions and extremely conflict sensitive. Against this backdrop the question arises if the conservancies are solutions to or causes for conflicts in pastoral borderlands?

Keywords: Kenya, pastoralism, violent conflict, wildlife conservancy

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Planning in Conflict – Experiences with the Conflict-Sensitive Programming Approach "Do No Harm" in Pastoralist Settings

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How may aid be provided in conflict settings in ways that, rather than feeding into and exacerbating the conflict, help local people disengage from the violence that surrounds them and begin to develop alternative systems for addressing the problems that underlie the conflict? With conflict sensitive programming, aid agencies are enabled to deliver relief and, at the same time, ensure that their aid does not worsen conflicts and moreover provide alternatives to conflict. The two main ethnic groups that have been studied using the 'do no harm' approach are the Gabbra and the Dasanach. Both are living to the East of Lake Turkana in Northern Kenya in a harsh environment that does not allow much else than keeping animals in a pastoralist way. The issue of violent conflicts was found to be one of the major causes for the vulnerability. During the participatory exercise a reciprocal agreement on the sharing of pasture and water resources was achieved, the establishment of joint committees looking at water use and at peace issues, and the planning of common activities.

As environmental changes directly affect the livelihood of pastoralists, they are highly vulnerable to climatic events such as droughts, which lead to competition over scarce resources. As a result, most pastoralist environments are also marked by a high degree of inter-ethnic conflict, in which the access to water and pastures becomes a continuous object of tension. Relief projects working in such situations have to be aware of these aspects and assure that their interventions, whether in form of social services, economic assistance or infrastructure, are implemented in a conflict-sensitive way. This demand for the following considerations:

- Take an explicit decision to integrate conflict-sensitivity into programming.
- Determine the steps of an accompanying process for the staff leading to practical application.
- Develop conflict-sensitive indicators for measuring the success of a project.
- Decide on guidelines for the organisational presence in the field.
- Take an informed decision on whether peace-building should become an objective in itself.

Keywords: Conflict sensitive programming, disaster preparedness, do-no-harm methodology, humanitarian aid

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Assessing Social Vulnerability to Seismic Hazard through Spatial Multi Criteria Evaluation in Bantul District, Indonesia

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This research aims to test the spatial multi criteria evaluation (SMCE) feasibility for social vulnerability assessment in seismic prone areas of Bantul, Indonesia. The research area experiences at least these spatial problems (1) seismic hazard and (2) rapid land conversion (3) dominated by low income group. Bantul District experienced 6.2 Mw earthquakes in May 27th, 2006 which caused damages to nearly 80 % out of the 508 km^2 total area. It happens as home to nearly 823.000 people whom predominantly earn low to medium income from agriculture and non-agriculture sector. Additionally, there is rapid land conversion due to rapid population growth, urbanisation and transition from agriculture based economy to industrial based economy. The research method applies SMCE or spatial analysis application that allows diverse input criteria and operates through problem tree analysis, standardisation, weighting, lastly map generation. Herein, social vulnerability towards seismic hazard refers to pre-existing condition of being unfavourable due to seismic hazard expressed on a scale from 0 (no loss/damage) – 1 (lethal/full damage) within specified time. The research has revealed five findings, *i.e.* (1) social vulnerability indices are spatially quantifiable using SMCE, (2) the generated "deterministic what-if scenarios" built upon five criteria, *i.e.* physical, demography, social-economic, losses and hazard, (3) six scenarios distinguish the research area into moderately vulnerable, vulnerable and highly vulnerable indices, (4) social economic as sensitive criteria, and (5) weighting modification indicates result consistencies. In summary, the social vulnerability assessment using SMCE potentially stirs up better and safer future development plan albeit critically falls into ecological fallacy.

Keywords: Indonesia, seismic, social, spatial multi criteria, vulnerability

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Options for Enhancing Resilience of Rural Populations to Reduced Water Availability in Uzbekistan

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Central Asia is considered to be one of those most vulnerable to climate change and its anticipated effect, such as more frequent and prolonged drought events and reduced water availability. Reduced water availability will lead to crop failures and severely undermine livelihood of rural population. Modification of existing agricultural policies, that currently determine the water-intensive agricultural production, could make the rural population more resilient to reduced water availability. In this paper, we address the issue of fostering food security via agricultural policy solutions on the example of modifications in the state regulations over cotton production in the Khorezm province of Uzbekistan. To identify the grain prospects of modifying the cotton policy and the impact of the policy changes on land and water use in agriculture, we applied an integrated bio-economic model developed at scale of a water users association in Khorezm. Simulation results show that abolishment of cotton policy seems more viable option to improve food production rather available options to modify its settings. The study revealed that the same amount of cotton could be produced if the farm-gate cotton price was at world market level. This would allow an increase in total grain production without putting stress on water. The more flexible settings of cotton policy are likely to reduce land values meaning a potential loss of farmers' interest in investing in land improvement and conservation technologies. Consequently, there is a risk of exacerbating the vulnerability of irrigated agriculture in Uzbekistan due to land degradation, when cotton-growing policies are changed, not only abolished. However, if farmers are released from cotton production targets, the gross farm income may increase at the expense of higher demands for irrigation water. Supplemental agricultural policies and institutions are required for promoting more efficient water use and farm investments in land improvement.

Keywords: Agricultural policy analysis, cotton production, ood security, integrated farm model

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Precarious Livelihoods along India's Disaster-Prone Eastern Coastline: Socio-political and Environmental Dimensions of Vulnerability and Recovery

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In academic and policy debates there is increasing recognition and more explicit concern of the social dimensions of hazard and vulnerability, beyond their physical properties. Exposure to hazard results in disaster when the functioning of a community or society is seriously disrupted, when it is unable to cope using its own resources. Vulnerability encompasses not only the likelihood of physical exposure to the hazard, but also people's underlying susceptibility to its effects, and their ability to cope, respond and adapt. Recovery takes place when a household or community not only re-establishes its livelihood, physical assets and patterns of access, but when it becomes more resilient to the next extreme event (Wisner, Blaikie *et al*. 2004).

This paper draws on a multi-method research project undertaken in 2010 in Odisha, one of India's poorest states. The research sought to examine the environmental and socio-political dimensions of recovery and ongoing vulnerability of the coastal population through a programme of current and retrospective enquiry spanning ten years since the devastating supercyclone of 1999. Though falling in one of Odisha's more prosperous districts, the research locale is politically and economically marginal, with caste and ethnicity creating social marginalisation at the village-level. The research villages are located in an ecologically sensitive estuarine region where mono-cropped paddy cultivation replaced natural mangroves in the early and mid-20th century, and where prawn/shrimp farming has more recently been practised – with varying outcomes.

The paper demonstrates that ten years on from 1999, study households continue to experience a high degree of ongoing vulnerability with respect to livelihoods. The paper argues that the minimal recovery of livelihoods is related to the inability of the poorest households in accessing vital resources from the state and other agencies. There are clear limits to the extent of assistance available within the community beyond the immediate aftermath of a disaster. The central message of the paper lies in highlighting that in the longer term, recovery, and hence resilience is a function not just of the scale of a disaster but also of the resources people are able to access over a prolonged period of time.

Keywords: Coastal, disaster, environment, livelihood, politics, recovery, vulnerability

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GIZ session

How Can the UNCCD and other Conventions Support and Enable Sustainable Land Management in Fragile Ecosystems?

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Land, climate and biodiversity are inseparably linked. In 1992 three Rio Conventions were adopted at the UN Conference on Environment and Development (Earth Summit) in Rio to establish an international legal framework to meet the global environmental challenges referring to land, climate and biodiversity.

The Convention on Biological Diversity (CBD) focuses on the conservation of biological diversity and the sustainable use of its components, the UN Framework Convention on Climate Change (UNFCCC) has the objective to stabilise the greenhouse gas concentrations in the atmosphere and the UN Convention to Combat Desertification (UNCCD) aims at combating desertification and mitigating the effects of drought in affected countries.

In each of the conventions terms and aims, the conservation and sustainable use of fragile ecosystems have a high priority. Fragile Ecosystems are important ecosystems with unique features and resources, which are particularly vulnerable to the effects of climate change, desertification and loss of biodiversity and are therefore integrated in each of the conventions framework to be particularly worth protecting.

To fulfil the obligations and objectives of the three Rio conventions, Sustainable Land Management (SLM) is increasingly recognised as a common denominator of most environmental and development goals and is becoming a vital component of programmes to meet the global challenges, especially in highly vulnerable ecosystem, *e.g.* drylands.

However, based on experiences in the implementation process bottlenecks and challenges have become evident. As a multilateral agreement the conventions struggle to prove its effectiveness on the ground. In the case of the three Rio Conventions, National Action Plans (NAPs, NBSAPs, NAPAs), embedded in the conventions framework as binding instruments on a national level, have emerged as a popular tool to identify national options and strategies for implementation of global agreements. But still, global and national expectations from National Action Plans are often neither synergistic, nor realistic and need to be adapted on the basis of successful best practices and lessons learned.

Using the example of several existing successful initiatives and programmes implemented in drylands, the conventions prove its potential to establish and improve a national and international legal framework for implementation measures on the local level as well as to mobilise additional funds (*e.g.* GEF) for such measures. The Conventions also contribute to raise awareness amongst the national and international political and scientific community and thus put relevant environmental issues on the national and international political agenda.

Keywords: Conventions, Sustainable land management

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Participation of the Local Population in the Context of Large-scale Land Acquisitions and Leases

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In the last years, there has been a rising trend in what international headlines have termed 'land grabbing'. International and national investors (private, parastatal and state companies, sovereign wealth funds) are using long-term leases or purchase agreements to secure large areas of agricultural land in developing countries in order to grow food or energy plants for export or domestic consumption. In the aftermath of the financial crisis and in anticipation of further rises in agricultural prices, land is increasingly becoming a speculative asset for investors. According to the International Land Coalition, reported cases currently total at least 80 million hectares - more than double the size of Germany.

On the one hand, large-scale land acquisitions pose considerable risks, such as the violation of human rights or the loss of adequate access to land for the local population. On the other hand, they offer chances (increased tax income, improved infrastructure, supply of capital and technology etc.) which can be realised if strict conditions are met. In this regard, an international policy dialogue and a dialogue with the partner countries of development cooperation is needed, as well as improved transparency of investments and capacity building for professionals, amongst others.

One of the most common shortcomings of investments in land is insufficient participation of the local population in decision-making, negotiation and implementation of projects. This is often attributable to information asymmetry and power imbalances between the investor and the government on the one hand and the population on the other hand, corruption and patronage within governments of target countries and an unclear land rights situation.

GIZ supports around 30 projects on land policy and land management worldwide. Participatory land use planning and inclusive business models will be presented as two of GIZ's approaches for improving participation of the local population in the context of large-scale land acquisitions and leases.

Keywords: Land grabbing, land management, land use

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Sustainable Management of Resources in Agriculture in a Fragile and Resource Poor Context

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The concept of sustainable agriculture comprises three aspects: The production of biomass or animals should not deplete natural resources or make them unusable through pollution; socio-cultural aspects have to be considered, meaning that *e.g.* land use rights have to be respected and exploitation of labour must be eradicated; from an economic perspective, agriculture must pay off and be profitable so that people are able to make a living of it in order for development to occur. To put this into terms of the Green Economy: Growth must be decoupled from resource consumption. Such an economic approach protects fragile ecosystems and acknowledges ecosystem services as well as values them. Conventional agriculture is often only highly profitable, because the costs for environmental or social damages are externalized. If these costs were internalised, however, conventional agriculture would have no comparative advantage over a responsible, sustainable agriculture. Sustainable agriculture is profitable and the only future prospect for a socio-economic development, in particular in agrarian dominated countries, as being the case with many developing countries. One problem is marginal areas, such as the Sahel, where agriculture is predominantly at a subsistence level and resources are frequently depleted and the soils are consequently being degraded. The immense population growth, which caused a doubling of the world population within the last decades, makes it increasingly difficult to produce sufficient food without depleting the available resources. One consequence is increased desertification. In these contexts, a reorganisation of agriculture and animal husbandry may only lead to sustainable agriculture if backed by demographic policy. Under marginal conditions, knowledge as well as means of production, which could transform agriculture from subsistence oriented into sustainable market oriented agriculture, is often lacking. In regions, where the private sector has no interest to invest, it is even more the responsibility of governments to create suitable framework conditions, which promote the development of a sustainable production and enhance socio-economic development.

Keywords: Land use, sustainable agriculture

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Relevance of Agricultural Research for the Development of Sustainable Land Use Based on Agroforestry Systems in semi-Arid Areas of Bolivia

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In contrast to mono-culture agricultural practice, agroforestry systems combine trees and other crops in integrated production systems for home consumption as well as for sale. There is evidence from both research and field experience, that agroforestry systems can be an economically as well as environmentally sustainable option especially for small-scale farmers to sustain productivity of their enterprise. In Bolivia, agroforestry land use practices are getting more and more emphasis due to the long-term benefits in the conservation of soil and protection of water resources and its capacity to buffer against climate related impacts. To maintain agriculturally productive zones in arid and semi-arid ecological areas in Bolivia is a challenge in the light of negative effects of climate change and increasing population. There is raising interest to test and promote more resilient agricultural production systems than those currently practised.

Over many years, a team of international and national experts of the GIZ (former German Development Service) has supported local initiatives (farmers organisations, NGO) and facilitated the creation of a network to develop economic opportunities for rural areas and to support the implementation and sustainable management of agroforestry systems in tropical areas in Bolivia.

In order to support small farmers in mountainous semi-arid regions to adapt to effects of climate change, a joint learning approach through investigation is called for. This needs to involve people from local communities, farmers' organisations, municipalities, NGO and extension services. Added to that knowledge from outside, the local situation should also be drawn in. Universities, research institutions and development organisations can provide such know how. In rural areas one of the big challenges for small farmers and one of the bottle necks for rule development is the insufficient exchange and flow of information and knowledge. Key elements of successful sustainable land use approaches therefore are joint technology development and joint monitoring that involve local knowledge and scientific expertise.

Keywords: Agroforestry, local knowledge, sustainable land use

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Rural services

Is the Provision of Agricultural Extension Services Better under Decentralised than under Centralised Government Systems? The Case of Uganda

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Efforts to improve the delivery of rural services in developing countries have revolved around decentralisation policies, which have been seen as a promising approach to increase responsiveness of governments to people's needs by makingrural services demand-driven and empowering communities to determine their development. This paper examines the performance of Uganda's agricultural extension under a decentralised system. We analyse the performance of decentralised service provision in Uganda using data collected from 208 agricultural extension agents (AEAs), which were affiliated with (1) the National Agricultural Advisory Services (NAADS) and (2) non-governmental organisations (NGOs), both of which provide demand-driven services, and with (3) the government, which provides traditional agricultural extension services comparable to services under a centralised system. The paper combines qualitative approaches to analyse the perceptions of AEAs and other key informants with econometric approaches to determine the factors associated with of the performance of service provision.

AEAs and local government leaders observed that decentralisation brought services closer to the people, empowered farmers to demand better services, and allowed them to monitor providers of advisory services more closely. The major weaknesses of decentralisation were seen in limited staff promotion, increased political interference, and poor vetting of candidates applying for positions to serve as private advisory service providers. There was also the perception of corruption and weak regulation and monitoring of private providers. The econometric results showed that AEAs affiliated with NAADS and NGOs provided services to a significantly larger share of farmers under their jurisdiction than government-affiliated AEAs – reflecting the better incentives provided to non-governmental AEAs. Moreover, AEAs affiliated with NGOs were more likely to provide advisory services to women than government-affiliated AEAs. This is consistent with Swanson (2008), who found that NGOs are better able to serve women and other vulnerable groups. Government-affiliated AEAs were more likely to offer advisory services on traditional technologies such as improved seeds than AEAs affiliated with NAADS or NGOs. The results highlight the complementarity of different types of advisory service providers to provide a variety of management practices.

Keywords: Agricultural extension, decentralisation, outsourcing, Uganda

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Gender Differentials in Agricultural Extension Services: Empirical Evidence from Uganda

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Considering the important role of women in African agriculture, providing agricultural advisory services to women farmers is essential for pro-poor agricultural development. Yet, reaching women,especially in marginal areas, has remained a challenge for agricultural extension providers. The paper presents the findings of a survey conducted in 2005 to assess the gender gaps in Uganda's liberalised, pluralistic and decentralised extension system. The objective of the study was to derivepolicy implications for gender-responsive interventions aimed at enhancing access to agricultural extension to women, based on an analysis of empirical quantitative data on the gender gaps in Uganda's agricultural extension system.

The study assessed effectiveness of the three types of extension providers (the public, NGOs and the NAADS programme services) in reaching women farmers as well as in providing a conducive work environment for female agricultural extension agents (AEAs). The study was found that female AEAs accounted for only 11 % of extension staff, and a majority of them were located in districts neighbouring urban centres. Some districts had no female AEAs at all. With regard to differences between male and female extension service providers' access to working resources and facilities, men were found to have greater access to motorbikes compared to women.This gap was widest in NGOs, followed by NAADS and the government, in that order. There was no significant difference in access to office mobile phones and official airtime formale and female AEAs in all three types of extension systems, except for government where women had greater access. Female AEAs accessed the internet more intensively thanmale AEAs,but the difference was not statistically significant. Using a Maximum Likelihood Probit Regression model, the study identified age, level of education and organisational affiliation as main determinants of access to motorbikes and internet by AEAs. Expectedly, younger and better educated AEAs were more likely to have access to the internet. NGO-affiliated AEAs were also more likely to have access to internet than government-employed AEAs.

A two limit tobit model revealed that the gender of the AEAs and their organisational affiliation were key determinants of the types of farmers served. In line with other findings in the literature, female AEAs were more likely to provide advisory services

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to female farmers than male AEAs. The study also found that AEAs affiliated with NAADS and NGOs were more likely to provide advisory services to women than government-affiliated AEAs. There was a higher adoption of new technologies by male farmers who received advisory services from government and NAADS-affiliated AEAs for all technologies reported. However, adoption rates were higher for female farmers who received advisory services from NGO-affiliated AEAs on agrochemicals and plant protection than was the case for male farmers. The paper derives recommendations for addressing the gender gaps identified in the study.

Keywords: Gender gaps, pluralistic decentralised agricultural extension, Uganda

Cooperatives as Service Providers: The Revival of Agricultural Cooperatives in Uganda

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Since the liberalisation of markets, the cooperative sector in Uganda has gone through a dynamic process of restructuring and adjusting to the conditions of a liberalised economy. Following a trend that is also observed in other countries, the reformed cooperatives are expected to avoid the mistakes of the past that had led to an almost complete collapse of the cooperative sector. They aim to increase rural incomes and to link farmers to markets with the overall goal of reducing rural poverty. This paper presents the results of a survey of 407 cooperative members from eight Area Cooperative Enterprises. The paper focuses on the recent revival and restructuring of agricultural cooperatives in Uganda and the ways in which they contribute to improving rural livelihoods and reducing poverty. Evidence shows that strategies employed to reform the cooperatives included (1) strengthening grassroots organisations, (2) introducing Area Cooperative Enterprises to improve market access and realise competitive prices for Rural Producer Organisations, and (3) building stronger linkages with Savings and Credit Cooperative Organisations. The analysis of the data collected from cooperative members shows that participation in the reformed cooperatives contributed to increased incomes, acquisition of basic household items, increased production and productivity, increased ability of members to feed their families two to three meals a day, and increased household savings. Reviving the agricultural cooperatives proved effective in linking rural farmers to profitable markets, enabled them to more successfully bargain for higher prices, improved their access to financial services, and increased their farming knowledge to increase production and productivity. The study also indicates that there is, however, a need to address the challenges of under-capitalisation and to promote full member participation.

Keywords: Area cooperative enterprise, cooperatives, poverty, rural producer organisation, savings and credit organisation, Uganda

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The Politics of Local Public Good Provision: A Comparative Study from Andhra Pradesh, India

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The role of infrastructure to enhance pro-poor growth is particularly pronounced in developing economies. In India, decentralized governance arrangements and assembly constituency development programs are among the major public channels through which infrastructure is delivered to rural communities. However, it has been observed that there are considerable regional disparities in local public good outcomes, not only among federal states, but also at regional and community level.

Previous studies in the Indian context focused on demand-side pressures, socio-economic fragmentation or information asymmetries to explain local variations in policy outcomes. A major drawback of existing research is that communities are often conceived as isolated entities, neglecting the fact that the provision of local public goods constitutes a polycentric governance phenomenon.

This study investigates the supply-side of government in rural infrastructure delivery. A controlled case study approach was employed to shed light on the governing process in three communities of a backward district in Andhra Pradesh. We comparatively analyze how both local leaders and Members of the Legislative Assembly (MLAs) bargain over the provision of village roads and drinking water facilities. Institutional theories are updated with insights from bargaining models to explain the policy agency of elected representatives.

Our findings underline the importance of a generally neglected factor in the literature on community governance and distribution: variations in local representatives' attachment to political parties. In the prevailing governance set-ups, party politicians at higher government levels strongly influence the decision-making processes on infrastructure resources in village councils. Distinct combinations of moral leadership and responses to potential politico-economic benefits translate into varying bargaining strategies of actors and hence different public good outcomes in the communities under review.

The institutional arrangement of parallel provision channels does not only create ambivalent incentive structures, it may also threaten the mandate of local governments to deliver infrastructure facilities in an efficient manner.

Keywords: India, party politics, polycentric governance, rural infrastructure

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Reforming the Public Administration for Better Service Provision: A Comparative Study of Five Rural Services in Karnataka, India

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Strategies to reform rural service provision in India have focused on improving people's capacity to demand better services from government agencies, for example, through empowering locally elected councils and strengthening people's Right to Information. However, there have been limited efforts to reform the public sector agencies that provide essential rural services, such agricultural and livestock services, drinking water and child development services. Moreover, there are major knowledge gaps on how incentive problems and governance challenges vary across the agencies that provide such services, and how they can be addressed. This paper aims to contributeto closing this knowledge gapby (1) developing a conceptual framework for an institutional assessment of rural service providers, and (2) applying this framework for five rural services inthe Indian state of Karnataka. The conceptual framework relies onconcepts of the NewInstitutional Economics and on the organisational assessment literature. The empirical analysis is based on a survey of 206 field-level staff members of five government departments that provide rural services: (1) Agriculture, (2) Animal Husbandry, (3) Food and Civil Supplies, (4) Women and Child Development and (5) Rural Development and Panchayati Raj. The paper also draws on a survey of 966 rural households that receive services from these departments. The analysis indicates that there are significant differences across departments regarding the incentives and constraints faced by their frontline service providers. Lack of staff was found to be a major constraint for agricultural and veterinary services, whereas frontline staff in charge of food distribution and civil works experienced political interference as a particularly serious constraint. Availability of funding and administrative procedures were not considered to be major constraintsacross departments. The findings from the household survey indicate that access and satisfaction with services differsignificantly according to caste and gender, even though these effects are not uniform across services. The paper comparesthe findings of the study with therecent recommendations of the Second Administrative Reform Commission and concludes that some constraints, such as political interference, require more attention to make service delivery responsive to the needs of the poor.

Keywords: India, public sector management reform, rural service provision

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Understanding the Exercise of Discretion in Community Forestry Policy Implementation: Application of Street-level Bureaucracy Theory to a Case Study from Nepal

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The community forestry (CF) programme of Nepal is one of the oldest and allegedly most successful programs worldwide. Concurrently, policy implementation research shows that the Nepalese CF programme is still struggling with some severe implementation deficits. The forest bureaucracy in Nepal, for example, is characterised by a rather inflexible, top-town culture of decision making. Nevertheless, there is quite substantive variance in achieving CF policy goals in different parts of the country. This paper tries to explain part of this variance by focusing on one key element in the "chain of implementation", namely the activities of front-line staff of the Department of Forest (DoF). The main aim of this paper is to examine how front-line workers exercise discretion while enforcing CF polices and to elucidate what factors influence their behaviour in their daily interactions with clients.

Conceptually, the paper draws on general insights from bottom-up approaches to policy implementation research and it employs a particular theory of this strand of research,*i.e.* street-level bureaucracy (SLB) theory. Building, inter alia, on the work of Michael Lipsky, SLB theory puts a special focus on public service workers who interact directly with citizens in the course of their jobs and who have substantial discretion in the execution of their work.

Methodologically, the study employs a small-N research design and mixed qualitative/quantitative investigation methods. Primary data was gathered by means of 100 semi-structured face-to-face interviews with government forest officials and 50 interviews with representatives of 45 community forest user groups.

The empirical results of the study indicate that the exercise of discretion at the front-line in CF implementation is more or less inevitable. The findings suggest that the discretionary power that street-level bureaucrats are able to exercise, is an important explanatory factor for the achievement of policy objectives at the implementation level. SLBs employ different informal procedures and strategies that help them to manage the sheer unlimited service demand from their clients, especially in the light of limited organisational resources and in presence of great leeway in CF policies. Based on these findings, some general policy-relevant conclusions are drawn.

Keywords: Clients, community forestry, informal behaviour, policy implementation, street-level bureaucrats

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The Role of Participatory Governance for Overcoming Information Asymmetries in Rural Political Markets: A Case Study in Guatemala

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This study addresses the question how information asymmetries can be overcome in rural political systems, which are analysed as political markets. Previous research shows that increasing voter knowledge about government performance is a key condition for making elections work as an effective accountability mechanism in developing countries. Yet, how this can be best achieved remains unclear. Therefore, we examine the potential of participatory governance forums to transmit information about government decisions to poor voters in rural areas of Guatemala. The suitability of participatory governance as an information provision mechanism has not been examined so far in the literature on political market imperfections in developing countries. Hence, we complement previous political economy research on the interaction between elections and other information provision mechanisms, such as the media, central government audit reports and information campaigns. At the same time, we add to the literature on the effects of participatory governance reforms by exploring a new mechanism through which these reforms can improve local government performance.

The empirical analysis of the study consists of a comparative case study of two Guatemalan participatory governance forums, the so-called Municipal Development Councils.The two municipalities were selected from a pool of ten cases which were studied in a broader research project on public service provision in rural areas.They represent the two extremes of a highly effective and an ineffective participatory governance forum.In both cases, we study what type of information these forums provide, how they convey this information and what audience they reach. Then, we examine the performance of the local governments in the two municipalities. Finally, we analyse what conditions explain the difference in the effectiveness of the two participatory governance forums in providing information about policy decisions to rural voters.

The results show that a local participatory governance forum that functions effectively can reduce the information asymmetry between a local government and its electorate and, thus, contribute to better local government performance. In line with previous research on the implementation of participatory governance we also find that a high familiarity of citizens with the rules, a dense civil society and low costs of attending meetings are crucial for making a participatory governance forum an effective information provision mechanism. Moreover, the results of our study suggest that village

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representatives and civil society actors' knowledge of their rights and their technical and organisational capacities to claim them can be increased effectively in the short- to medium-run by capacity building in spite of low levels of education. Finally, our results indicate that the formation and the functioning of civil society organisations can be promoted through capacity building and group-based fund allocation and that in places with high povertymitigating the cost of participation for village representatives and civil society actors can foster participation.

Keywords: Decentralisation, Guatemala, information asymmetries, participatory governance

Reforming the Provision of Irrigation Services: Water Users Associations and Agricultural Production in Kyrgyzstan

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Decentralisation of responsibility for the operation and maintenance of irrigation infrastructure and control over the allocation of water to user groups has become a major policy trend in developing and transition countries worldwide. This policy trend has been the result of various factors, including greater awareness of incentive problems and need for local collective action in irrigation water management (Bardhan 2000; Araral 2009). The evidence on the outcome of these reforms is, however, rather mixed (Theesfeld 2004; Huang et al. 2009). Institutional reform in water management is particularly important in Central Asia, where the agricultural sector largely depends on irrigation and where local irrigation infrastructure originally was built for large-scale state and collective farms. Following the abolition of state and collective farms and the transition to an individual farming system in 1990s, the establishment and promotion of water users associations (WUAs) have important implications for improving agricultural production in the region. WUAs operate and maintain local irrigation facilities and regulate water allocation at the community level. This paper examines the impact of WUAs on agricultural performance in Kyrgyzstan. Using community-level primary data collected in 2009 through an institutional survey and official statistics from national sources, the paper provides empirical evidence on the question whether WUAs have a positive impact on agricultural production. The empirical methodology applied in the study included multilevel regression analysis and an instrumental variables approach, which makes it possible to control for heterogeneity in the relationship between water users associations and agricultural production across provinces and rural districts. The paper also considers the potential linkages between changes in irrigation water management and other agricultural reforms, and discusses existing institutional and policy constraints that hinder agricultural growth and productivity in the country.

Keywords: Irrigation management reform, Kyrgyzstan, water user associations

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Providing Safe Drinking Water in Guatemala: Comparing the Role of Local Governments, Communities and the Private Sector

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Supply of safe drinking water is one of the most important services that governments need to ensure for their citizens. Yet, supplying reliable water services has remained a major challenge, especially in rural areas, and there is a controversial policy debate on the institutional arrangements that are best suited to meet this challenge. This paper compares three types of service provisionwhich co-exist for drinking water supply in Guatemala: the management of water supply by local municipalities, by local community groups, and by private enterprisesA conceptual framework based on concepts of the New Institutional Economics, in particular Oliver Williamson's transaction costs approach, is used to identify the comparative advantages of the three systems, depending on contextual factors such as government capacity, community social capital, and households' income levels.

The empirical part of the paper is based on two sources of data: the 2006 Living Standards Measurement Survey, which provides nationally representative household data, and a community-level survey that was conducted in 200 rural communities in Guatemala in 2010. The analysis of the household level survey shows that access to water is far from being universal, particularly in rural areas, and existing water systems are often unreliable to provide safe drinking water. Hedonic models are estimated to investigate the value that households assign to the three institutional options considered in this study: municipal, private and community-managed water supplies. Rental prices and households' choice of water provider are modeled simultaneously using maximum simulated likelihood estimation (with 200 simulation draws per observation) in order to control for the potential endogeneity of access to different types of water services.The findings indicate that households in both urban and rural areas value municipal water services. Urban households also value private water supply, although the estimated value for private services is lower than for municipal supply. Contradicting a major trend in providing water services, there seems to be resistance to community-managed water systems in both urban and rural areas, which may be linked to the efforts required in managing such systems.

The community-level survey confirms the problems of rural drinking water supply found in the household level data analysis. The community survey entailed an empirical measurement of contamination levels of drinking water, using a special test kit.

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The analysis showed that more than half of the rural communities do not have access to portable drinking water. Moreover, even where water services exist, contamination levels are high across the different management systems. Based on the analysis, the paper draws policy implications regarding the institutional arrangements for drinking water supply in Guatemala. The paper highlights the role that an effective public sector needs to play to ensure safe drinking water for all citizens.

Keywords: Decentralisation, drinking water supply, Guatemala, institutional arrangements

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