

Tropentag 2005

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

**The Global Food & Product Chain –
Dynamics, Innovations, Conflicts,
Strategies**

Book of Abstracts

Editors:

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University of Hohenheim, Stuttgart

October 11-13, 2005

Impressum

Die Deutsche Bibliothek — Cataloguing in Publication-Data (CIP)

The Global Food & Product Chain — Dynamics, Innovations, Conflicts, Strategies: international research on food security, natural resource management and rural development; book of abstracts / Tropentag 2005 Stuttgart-Hohenheim.

Hrsg.: Eric Tielkes, Christian Hülsebusch, Inga Häuser, Andreas Deininger, Klaus Becker

ISBN: 3-00-017063-4

© Universität Hohenheim, Tropenzentrum, Centre for Agriculture in the Tropics and Subtropics, Stuttgart, Germany

Editors:

Eric Tielkes, Christian Hülsebusch, Inga Häuser, Andreas Deininger, Klaus Becker

Online-Versions:

Print-Version, pdf: <http://www.proceedings2005.tropentag.de>

Web-Version, HTML: <http://www.abstracts2005.tropentag.de>

Layout:

Eric Tielkes, Inga Häuser, Andreas Deininger

Typesetting:

L^AT_EX 2_ε

Printed by:

MDD Media Digitaldruck Copy Shop Büromaschinen GmbH

Wollgrasweg 27

70599 Stuttgart

September 2005

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Preface

The Tropentag is the International Conference on Research for Development in Agriculture and Forestry, Food and Natural Research Management - an annual event alternately organised by the Universities of Berlin (Humboldt), Bonn, Göttingen, Kassel (Witzenhausen) and Hohenheim in co-operation with the Council for Tropical and Subtropical Agricultural Research (ATSAR), the GTZ Advisory Service on Agricultural Research for Development (BEAF) and the German Forum on Research for Development (DFOR).

The Tropentag 2005 is the seventh annual meeting providing a forum for scientists, experts and students involved in research for development. The Tropentag 2005 conference theme is The Global Food & Product Chain - Dynamics, Innovations, Conflicts, Strategies.

Sustainable use and conservation of natural resources are priorities of the international community. Land, freshwater, energy, and biodiversity in natural and agricultural ecosystems are resources increasingly at stake. With view to the growing world population, the supply with agricultural commodities and food, food security, -quality and -safety must be achieved through an ever more efficient use of resources rather than through extending resource use. Achieving the United Nations Millennium Goals requires a considerable rise in overall food production, in which many international stakeholders take an interest. This leads to a global use of local resources, with global actors increasingly dominating the competition for access to these resources. The globalisation of food markets and the regulation of production through certification as means of consumer and market protection favours food industries rather than smallholder agriculture. With increasing globalisation, local food chains are articulated into a global food web, in which large scale agriculture serves the world market whereas smallholder agriculture rather serves domestic demands. In this context, not only industrialised agricultural production but also post harvest and food processing industries gain importance. A multitude of new issues arise in the field of resource definition, allocation, and use.

The Tropentag 2005 addresses the dynamics of the above processes, conflicts arising there from, strategies to overcome these conflicts and contribute to attaining food security and food safety and innovations that could form part of these strategies.

The organisers are overwhelmed by the large number of submitted contributions from scientists in Europe, Africa, Asia and Latin America, underlining the Tropentag's reputation as an international event on the agenda of the development oriented scientific community and decision makers alike. The programme and proceedings are published on www.tropentag.de.

The organisers acknowledge the generous support obtained from the following institutions:

- Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ) — Federal Ministry for Economic Cooperation and Development
- Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH — German Technical Cooperation
- Deutsche Forschungsgemeinschaft (DFG) — German Research Foundation
- Eiselen Foundation Ulm
- University of Hohenheim

Hohenheim, September 2005

for the Organising and Scientific Committee

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Dr. Christian Hülsebusch

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Market Requirements, Animal Health and Food Safety

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International Standards: Threats or Chances for Livestock Producers of Developing Countries? The EU as Example

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Globalisation is leading to a different perspective on animal farming, production and livestock products. The focus of this agriculture transformation in the developed countries is not on fostering production per se but on inclusion of considerations of public health (zoonoses), sustainable development and productivity of agriculture (environment), animal welfare, safe trade in animals and their products and food safety (farm to table approach). Rule-based trade and food safety under WTO's SPS agreement in particular exert a 'pull-push effect' also for producers in developing countries where they challenge costs, administrative, technical and other capacities to comply with international standards or with providing conditions recognized as equivalent with these standards.

The European Union (EU) attracts imports; the EU, being the world's biggest importer of foodstuff, mostly from developing countries, and also being the world's second largest exporter of value-added foodstuff has established complex policy (Common Agricultural Policy, CAP), structures and extensive legislation which extend to developing countries. With changes in CAP, this complexity of standard setting for high-value foods will increase to a package of safety, quality, environmental, social and ethical and will also involve non-trade concerns.

For developing countries, rather than seeing international standards as trade barriers, they can serve as change catalyst for overall competitiveness strategies: supply-chain modernization will use investment, national consumers will benefit from adoption of better safety and quality control practices and the appropriate and necessary roles of government and the private sector will be clarified. Countries, by thinking globally, will have to act locally.

Keywords: Globalisation, food safety, public health, animal health

Institutional Innovation for Pastoral Access to Emerging Export Markets for Small Ruminants: Case from East African Rangelands

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Poor access to markets is an often-cited complaint of Borana pastoralists in the eastern Rangelands, when engaged in participatory rural appraisal (PRA) efforts. When it is decided to sell some stock, the animals often must be trekked for long distances to reach the few available markets. The major form of livestock export has been live animals and there was one major outlet.

The export strategy in the livestock sub-sector in Ethiopia is increasingly shifting from live animals to chilled/frozen red meat, which is dominated by chilled chevron (goat meat) to a large extent followed by mutton to Middle Eastern countries. The shift towards chilled meat export and the sourcing of supplies from the southern rangelands led to the initiation of pilot pastoral livestock marketing activities within the existing saving and credit groups organised by the Global Livestock Pastoral Risk Management Project (GL-CRSP PARIMA). The market linkage pilot activity is a joint effort of GL-CRSP PARIMA, AU IBAR, and other partners in the region.

This paper outlines the process (a mixed mode of public engagement, extension education, and participatory action research) that has been undertaken over a couple of years in assisting pastoralists to voluntarily engage in grass-roots savings and credit associations, livestock marketing efforts, and various forms of livelihood diversification. We have documented sequential outcomes from over 20 local and regional tours, workshops, meetings, and short-courses for pastoralists, marketing agents, and policy makers conducted in the rangelands. The overall goal of this suite of interventions is to develop a sustainable capacity to better empower pastoral communities to manage risk. By taking this approach there is also a fundamental recognition of the need to help build human capital.

We postulate that a modest degree of pastoral economic diversification, as facilitated through improved livestock marketing systems, could have large benefits for pastoralists in terms of risk management, wealth conservation, improved resilience to shocks, and heightened food security.

Keywords: Economic diversification, local institutions and innovations, market linkage, pastoral food security, pastoral livelihood

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Development of a Livestock Production Performance Database for Policy Planning and Evaluation in South and Southeast Asia

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Quantitative livestock modelling can provide a means of ex ante assessment of the effect of interventions. FAO has developed the Livestock Development Planning System Version 2 (LDPS2), which can be used globally for livestock policy planning and evaluation. However, its wider application has been constrained by the scarcity of input data, i.e. livestock production performance values. Therefore, FAO initiated the development of the Livestock Production Performance Database (LPPD) for the compilation, classification and aggregation of relevant data extracted from the literature.

The LPPD can store parameters for 8 livestock species. Further variables contain information on geographic location and production system. Database output includes selected aggregates of individual parameters and output tables for data transfer to LDPS2. In the application described here, the compilation of data from the literature, comprising regular publications and grey literature, has focused on 9 countries in South and Southeast Asia. The database standards severely restrict the literature suitable for entry. However, aggregates of data conforming to the standards can be directly used for modelling with LDPS2.

The systematic compilation of data enables the identification of geographic areas, production systems and parameters, for which little information is available so far. The amount of information from Southeast Asia is far less than from South Asia. Generally, management related data (e.g. life cycle periods such as 'time in breeder herd' and mortality rates) are reported less often than milk yields or live weights. For poultry, differentiation of information by level of commercialisation is pivotal. Data availability determines possible levels of disaggregation. Currently, parameters are aggregated at the sub-regional level with a simplified production system classification. Alternatively, only parameters and systems with a sufficient number of parameter values are compared. For countries where sufficient information is available, LDPS2 results based on LPPD data correspond well to values reported in databases such as FAO-STAT or GLiPHA, validating LPPD information. The identification of more literature will improve the utility of the database and making the database accessible via the internet is expected to increase the number of users.

Keywords: Herd modelling, livestock, performance parameter database

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Support Policy Strategy for Avian Influenza Emergency Recovery and Rehabilitation of the Poultry Production in Viet Nam

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The Vietnamese Ministry of Agriculture and Rural Development is currently elaborating the implementation of the Avian Influenza (AI) Emergency Recovery Project. The Government of Viet Nam is supported by the International Development Association in cooperation with the Food and Agriculture Organisation of the United Nations (FAO), World Bank (WB) and the Japan Social Development Fund (JSDF).

National compensation strategy study is a component of the project. The objective is to prepare a strategy for a National Compensation Policy for Highly Pathogenic AI to strengthen the policy now in place. The methodology for the rapid appraisal of the support strategy for AI was based on: (1) Qualitative interviews at three different administrative levels (central, province and district levels) as well as with farmers. (2) Quantitative data analysis on financing activities related to the AI support strategy and (3) Economic impact assessment based on statistical data obtained from the Vietnamese Ministry of Finance and General Statistics Office. The work was carried out in December 2004 and April 2005.

Recommendations for the support policy strategy for AI were elaborated. This policy aims at preventing the public health threat derived from AI as well as reducing the economic losses at national level associated to the outbreak. The policy rationale is to encourage farmers to declare the disease at an early stage so as to contain the disease spread among the poultry farmer population. Key to the support policy is the level of compensation given to farmers in order to encourage them to cull the birds and avoid illegal selling to the market. The financial support policy therefore debates what the adequate risk-sharing patterns between public central government funds and poultry producers should be. Such patterns are closely related to the restructuring of the poultry production sector in Viet Nam.

Keywords: Avian Influenza, economic impact, public health threat, risk-sharing pattern, support policy, Viet Nam

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Requirements for Investigations of Animal Food Chains

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Concerns regarding the safety of foods of animal origin have increased in recent years as a consequence of ever-emerging hazards associated with food production and supply chains. These hazards cause various risk-threats to human health. Concerns are being spurred on by requirements related to the globalisation of trade of agricultural goods and by perceptions of consumers regarding food safety. International mandated organisations like the Codex Alimentarius Commission and trade blocks like the European Union responding to the concerns in consequence have embarked on an integrated approach to assure a high level of food safety and quality from farm to table covering all sectors of the food chain, including feed production, primary production, food processing, storage, transport and retail sale.

Investigations of food chains and determination of risk factors for the transmission pathways of agents along the chain require a new research approach: the preharvest stage has to be added and integrated to investigations which traditionally have focused on the harvest and the postharvest stages. Achievement of this requires high quality data on the various multiple stages of the food chain which in turn calls for the involvement of multi-disciplinary teams and multidimensional research approaches. Data would be used in the development and validation of state-transition risk assessment models that would provide insight in epidemiological consequences of food hazards and the efficiency of safety measures.

The paper presents experiences with the design and implementation of a food chain investigation approach for *Salmonella* infection in the pork chain in Northern Thailand. Marked animals and samples from them were followed throughout the chain and *Salmonella* prevalence were investigated in respective stages during the production line, transportation, lairage, slaughter and in pork products in retail markets. Investigation problems encountered and solutions used at different stages are presented.

Keywords: Animal food chains, investigation design, pork chain, Thailand

Strategies for Improved Nutrition of Livestock and Fish

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Plant-derived ingredients as protein sources in aqua-feeds

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As the human population continues to expand, its reliance on farmed fish production as an important source of protein will also increase. Aquaculture contributed ca. 40% to the total human food consumption of about 101 million metric tonnes in 2002. FAO estimates that aquaculture will dominate food fish supplies by the year 2030 and more than half of the fish consumed is likely to originate from this sector. This projected increase in aquaculture production would demand a concomitant increase in the production of aqua-feeds. The projected total production of aqua-feeds in the year 2010 is as high as 33 mmt against a production of about 17 mmt in the year 2001. The requirement of aquaculture feeds is likely to be further increased by the increasing trend of intensification of farmed production of omnivorous species in Asian countries, particularly China. Fishmeal is the most suitable source of protein in fish feeds. Environmental concerns, availability problems and high cost of fish meal have resulted in attempts at its replacement in fish feeds with alternative protein sources. Several plant derived protein sources such as soybean meal, cottonseed meal and canola meal are being used to replace fishmeal in aqua-feeds. Lack of essential amino acids, especially methionine, cystine, lysine and tryptophan, presence of antinutritional factors, lower palatability and problems with high fibre contents, especially in leaf meals, have been negative factors as far as inclusion of plant ingredients in fish feeds are concerned. The talk discusses these aspects and the importance of the development of feed ingredients from non-conventional plants whose production growth can cope up with the projected fast growth of the aqua-feed sector.

Keywords: Aqua-feeds, fish meal, plant derived protein sources, protein quality, antinutritional factors, non-conventional plants

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Effects of Different Processing Methods of Pigeon Pea (*Cajanus cajan*) on the Haematology of African Catfish (*Clarias gariepinus*) Larvae

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The need to substitute fishmeal in animal feed has necessitated the use of plant derived feed-stuffs. Legume seeds have been highly favoured because of their rich protein composition, carbohydrate content, mineral content and widespread distribution in the tropics. However, only few of these plant proteins have been utilised and investigated. Problems of anti nutritional factors in these legumes have limited their widespread usage and direct incorporation into animal feeds. Different processing methods have been devised to remove or reduce the concentration of these factors. In this study *Cajanus cajan* was subjected to four different processing methods. These included milling raw, toasting, boiling and soaking. Effects of the different processing methods on the haematology of *Clarias gariepinus* larvae was evaluated. It was aimed at determining the best processing method(s) for optimum utilisation of pigeon pea meal for fish production. Twenty-one test diets were formulated to contain about 39.5 % crude protein. The control diet was formulated with fishmeal at 55 % dietary inclusion level. Five test diets each were formulated using four differently processed pigeon pea. While the dietary inclusion level of pigeon pea increased from 45—65 %, the fishmeal inclusion level decreased from 41—33 % in each of the four sets of experimental diets. The test diets were assigned randomly to triplicate groups of 7 fish in 10 l plastic aquaria. The average weight of fish was 0.46 g. The fish were fed at 5 % body weight in two portions daily for eight weeks. They were weighed biweekly and the ration adjusted accordingly. Blood samples were collected from 10 representative fish at the start of the experiment. At the end, each dietary group was pooled and blood samples collected from 10 fish. These were analysed in triplicates. Results obtained showed that haematocrit (PCV), red blood cells count, white blood cells count and haemoglobin concentration decreased significantly ($p < 0.05$) with increasing dietary levels of raw pigeon pea. Fish fed diets from other processing methods showed lower values than the control when compared with the initial status. Soaking for 16 hours enhanced best the fish weight gain and haematological values and seems to be the best processing method for *Cajanus cajan*.

Keywords: *Cajanus cajan*, *Clarias gariepinus*, haematology

Study on Effects of Incorporating Various Levels of Cactus Pear (*Opuntia ficus-indica*) on Dry Matter Intake, Water Consumption and Performance of Sheep

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Poor feed quality and lack of water are the major constraints for livestock production under arid conditions. To solve these problems, looking for potential plants is mandatory. Cactus pear is an extremely drought tolerant, highly productive, multipurpose and succulent plant. It has incomparably high water and land use efficiency. In cactus pear producing regions its fruits plays life-saving role during rainy seasons while livestock depend mainly on its cladodes during dry seasons and drought years. Under the latter circumstances, diarrhoea and bloat are reported to be major problems. In spite of its vital forage use, the nutritive value of cactus pear is little researched. This study aimed at determining the nutritive value of cactus pear, its contribution as source of water and optimum level of inclusion.

A three-months experiment, laid out in a randomised complete block design with eight sheep/treatment, was conducted. Cactus pear replaced the basal diet (grass hay) at 0, 20, 40, 60 and 80 % (T1, T2, T3, T4, and T5, respectively) on a dry matter basis. Diets were offered in individual troughs twice daily, aiming at 20 % refusals. Common salt licks were available ad libitum. Feed and water consumption and refusals were recorded daily. Animals were weighed weekly. Data were analysed using the SAS software JMP5.

Highly significant differences ($p < 0.001$) were observed for total dry matter intake (DMI), water consumption and live-weight change. The highest DMI was recorded for T4 with $100 \text{ g kg}^{-1} \text{ W}^{0.75}$ followed by T3 and the lowest was found for control, T1 with $77 \text{ g kg}^{-1} \text{ W}^{0.75}$. Sheep in T1 consumed the highest amount of water (1.24 l d^{-1}) followed by T2 (0.068 l d^{-1}) while sheep in T3, T4 and T5 drunk negligible amount of water ($0.008, 0.016$ and 0.006 l d^{-1} , resp.). Liveweight change was relatively high ($+17.5 \text{ g d}^{-1}$) in T3 and sheep on the control diet lost weight (-11.12 g d^{-1}).

In conclusion, cactus pear could optimally substitute grass hay up to 60 %. It has a substantial contribution in satisfying the water requirement of sheep. Thus, cactus pear could play a significant role in mitigating feed shortage in drought prone areas of the tropics and sub-tropics.

Keywords: Cactus pear, feed intake, hay, sheep performance, water consumption

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Performance of *Cyprinus carpio* (var. *communis*) Fingerlings Fed on Diets Containing Water Washed Neem (*Azadirachta indica*) Seed Cake

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Neem (*Azadirachta indica*) seed cake (NSC) has a high crude protein (CP) content that makes it a potential fish feed ingredient. This study aimed at assessing the effect of water washed neem seed cake (WWNSC) supplementation in the diets of *Cyprinus carpio* fingerling on their growth, feed intake, nutrient utilisation and change in body composition.

Four iso-nitrogenous diets were prepared using fishmeal, maize, rice polish, peanut cake, oil and a vitamin-mineral mixture. NSC was processed for detoxification through water washing. To the basal diets WWNSC was supplemented at 0 (Control) (diet 1), 50 g (diet 2), 100 g (diet 3) and 150 g (diet 4) kg⁻¹ and this supplementation substituted about 0, 7, 14 and 21 % of dietary CP content of plant origin. Twelve groups of ten *Cyprinus carpio* fingerlings in each group with an initial biomass of 101 g (avg. 10.1 ± 0.15 g) were stocked in 35 l fibreglass tanks. The diets were hand fed to satiation twice daily, to triplicate groups of fingerlings. At the end of 42 days experimental feeding final biomass in each of the tanks was recorded, fish were killed, homogenised and analysed.

The final biomass that was attained by the fingerlings fed diet 1 (145 g) and diet 2 (144 g) were similar, and both were significantly higher ($p < 0.05$) than that of those fed on diet 3 (108 g) and diet 4 (108 g). During study, the daily dry matter intake per 100 g⁻¹ body weight of fish fed diet 1 and diet 2 was about 17 % higher than that of fish fed diet 3 and diet 4. There was a decrease ($p < 0.05$) in specific growth rate (SGR) and protein efficiency ratio (PER) together with a depressed feed conversion ratio (FCR) with increased dietary incorporation of WWNSC, beyond 50 g kg⁻¹. The fingerlings accumulated increasing moisture as well as protein and decreased lipid in their whole body with feeding WWNSC incorporated diets. The study indicated that WWNSC could be incorporated at 50 g kg⁻¹ in the diet of *Cyprinus carpio* fingerlings without affecting growth, feed intake and nutrient utilisation. It is advantageous to partially incorporate such abundantly available cheap feed stuffs in the diet of fish to mitigate the chronic shortage of costly oil cakes in developing countries.

Keywords: *Cyprinus carpio*, feed intake, neem seed cake, nutrient utilisation

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Limitations in Fish Production in Yen Chau/Son La Province, Northern Viet Nam

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In Yen Chau district of Son La Province fish farming is one of the major activities of farmers belonging to the ethnic minority Black Thai. The typical pond system in this area is characterised by polyculture with grass carp, among other carp species and tilapia, a continuous water-flow and feeding of mainly grass and leaf material.

Data were gathered by conducting 70 open and 70 structured interviews in the district of Yen Chau and by monthly surveying of six selected fish farmers.

Average fish yields of less than 300 g m⁻² for a 2-year production cycle must be considered relatively low for a feed-based aquaculture system. Even though, around Yen Chau town most farmers own ponds, the demand on the local market can not be covered and fish must be imported from the lowlands.

The low productivity can be partly explained by a lack of training or extension services in the field of aquaculture. Grass carp are frequently affected by diseases which leads to high fish losses and is considered as the main problem in pond farming in that region. The quality of the stocking material is assessed as low, which is probably caused by inbreeding depression in the local hatchery. As paddy fields and ponds are linked by a common irrigation system, activities in the paddy fields, such as application of pesticides, may negatively affect ponds. Water shortages in ponds may occur when paddy fields start to be irrigated. Low water temperatures in winter frequently lead to mortalities of tropical fish species, such as tilapia. Feed resources become limited in the cold dry season and the general food base in this system seems to be adequate for grass carp, but not for other fish species.

Despite of those bottlenecks, fish farming contributes enormously to food security, generates income and plays a significant role in farmers lives. Small improvements in the system might lead to big increases in fish yields.

Keywords: Aquaculture, fish farming, limitations, Viet Nam

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Conflict Over Resources: No Need for Reconciliation?

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The paper investigates concepts of resources and the notion of reconciliation within the discourse of development. Giving examples from Sudan, Tibet, and New Zealand it will be argued that conflicts over resources not only have different structures, but also very specific histories. It will thus be asked, in how far standardised scientific tools are useful in conflict analyses.

Keywords: Conflict analyses, reconciliation

Efficiency or Fairness? Strategies, Conflicts, and Dynamics in the Commons as Reaction Towards Increasing Pressure from Globalisation

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Globalisation has been accompanied by an equally global tendency towards devolution of authority and resources from nation-states to regions and communities. Decentralisation and devolution in developing countries is said to enhance efficiency, equity and conservation of natural resources if accompanied by a broad-based participation in local public decision-making processes. Communities are consequently confronted with the ability to adopt their traditional strategies and to prevent emerging conflicts.

Investigations looking at the emergence of collective action for biodiversity conservation were carried out in selected communities of Namibia and South Africa within the scope of the BIOTA Southern Africa project. This paper outlines the importance of different forms of social capital, individual strategies and different community characteristics, which might help in absorbing shocks from globalisation. A quantitative analysis based on a socio-ecological framework encompassing multiple links between resource users, natural resources, public infrastructure providers and public infrastructure, shows how the outcomes of the different interactions arising from the framework depend on the amount of structural and cognitive social capital present and the resulting ability to form collective action. Cognitive social capital refers to shared norms, values, trust, and beliefs whereas structural social capital consists of social networks and groups supplemented by rules and procedures.

The results indicate that communities might benefit from globalisation, and generate new income possibilities through successful collective actions (e.g. community conservancies). In the post-apartheid era, local governments established sectoral committees in every village to boost decentralisation and participation. This was, however, done without having the resources for a long term commitment that rewards reciprocity and allows for the formation of trust or to change people's behaviour according to norms of fairness and solidarity. It is hypothesised that only the complementarity of structural and cognitive social capital explains a wide range of the observed variations in village performances. It is further explained how the path of institutional change is nested in the dynamic interactions of cognitive and structural social capital. In conclusion: Besides efficiency, fairness is needed to cope with the challenges arising from globalisation.

Keywords: Collective action, globalisation, institutional change, social capital, Southern Africa

Do Communal Rangelands Meet the Requirements of Livestock in Namibia?

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In communal areas little information exists about the quality and quantity of grazing and browsing resources and the intensity of land use. Spatial and temporal rainfall variability influences the net biomass production of Namibian drylands in an unpredictable way. The aim of this study is to compare the feed availability from communal rangelands vs. the requirements of current livestock densities in order to clarify whether the communal areas are over- or under stocked, and to which period of the year this applies.

Rangeland assessments in two semi-arid communal areas in north and central Namibia were carried out in October 2002 and in May 2003 along five transects. The estimated dry biomass of grazing (g m^{-2}) and browsing resources (leaf dry matter up to 1.50 m, on 10×20 m plots) were determined, and the content of crude protein and energy analysed. Requirements of mixed livestock herds were estimated based on maintenance levels adding 50 % energy for walking. In the community in northern Namibia (rainfall 500 mm a^{-1}), the rangeland resources met all requirements of mixed herds during the investigated periods. Livestock with a stocking density of 15 kg ha^{-1} used 17.3 % of total resources during the wet season of 8 months, giving scope for production development.

In central Namibia (rainfall 250 mm a^{-1}), estimated feed resources in October 2002 fully met the requirements of current livestock with a stocking density of 42 kg ha^{-1} until the first efficient rainfall in December 2002. However, consecutive dry weeks during rainy season caused a drought in 2003 although the rainfall sum was not extremely low. Consequently, the biomass supply was deficient during the most important period for livestock reproduction. Cattle were found in poor condition in May 2003, and farmers started to transfer their cattle to distant areas to prevent mortality.

The commonly mentioned inter-annual rainfall variability insufficiently explains changes in rangeland resource availability. Critical is the distribution within the rainy season, especially the wet-day persistence of rainfall. Flexible responses, such as tracking or modern ways of mobility by trucks, should be encouraged in order to sustain the range resources in case of erratic feed shortage.

Keywords: Browsing, communal natural resources, grazing, livestock requirements, Namibia

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Challenges in Community Forest Functioning under Political Conflicts

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Community forestry in Nepal has been widely recognised as one of the most successful examples of Community-based Natural Resource Management initiative in any developing country. It has been initiated in the late 1970s in eighteen districts in the Middle Hills region; by 2001 the community forest had expanded to cover 73 out of 75 districts in the country. Large amounts of aid money and loans have been provided over the past two decades to various State agencies, NGOs and INGOs to facilitate the program. The international development community views Forest User Groups (FUGs), formed under the Community Forestry Programme (CFP), as institutions that not only facilitate local natural resource access and management, but also as vehicles of decentralised governance at the community level.

Meantime, the country has been facing serious political conflicts, which has extended terrorism and claimed thousands of human lives. The situation starts from the rural level where community forest targets and function well with the technical and extension support from government and non government organisation have been available. Several bilateral and multilateral development agencies have kept interest not only to continue necessary support but also they are learning themselves and their experiences have been proliferated worldwide. Now the community owned forest areas are being the inhabitants and so-called practice field of both revolutionarily group and government security. It is difficult for the people to go into the forest. Nowadays, there are several cases that even the local users became victim while entering the forest for their livelihoods.

This paper will discuss some potential strategies to better functioning of the resources management by the people themselves. The basis of the discussion in the paper was supplied by secondary sources from national and international journals and own interaction with forestry stakeholders in the country. Because of lack of external monitoring, internal conflicts have also be seen in some cases. Mobilisation of user groups by themselves either by their knowledge or through user group networks is some mechanism to get success despite the situation.

Keywords: Community based resource management, community forest user group, conflicts, Nepal

Identifying Priority Policy Issues to Reduce Soil Degradation: Evidence from a Statistical Analysis for Asia

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Soil degradation is a severe problem in Asia. The strong role of socioeconomic factors for (un)sustainable use of natural resources is acknowledged. Yet, competing hypotheses exist about single causes. Policy measures against soil degradation have been adopted, but it proves difficult to achieve major improvements. In short, there is need for informed advice for policy making. Policy making requires both a generalised picture on relationships among key factors, and differentiated, site-specific recommendations. Availability of data is a major obstacle to monitoring and analysis. This work therefore aims at developing a statistical framework satisfying the information needs and suited to available data for Asia.

An analytical concept called “agricultural development patterns” is designed, differentiating degradation issues and causal relations by sets of agricultural conditions. A regional, spatial analysis combines the possibilities for generalisation inherent to large scale analyses with the detailed description of high resolution analyses.

Exploratory methods (factor and cluster analysis) are used to determine agricultural development patterns and logistic regressions by cluster to indicate causes of degradation. Compiling, inspection and integration of geo-referenced data on soil degradation, natural and socioeconomic conditions, and land use were important analysis steps. Six agricultural development patterns are identified — “intensive, cropland”, “intensive, livestock”, “expanding cropland, humid”, “mountain areas”, “marginal high mountains” and “rainforest” — showing different degradation problems.

Results show strong support for the pessimist view of degrading effects of population pressure and poverty: the two are important causes of soil degradation throughout clusters. The effect of agricultural growth is less uniform: expansion acts as cause of water erosion, whereas intensification plays a less critical role. Specialisation in small ruminants and lack of market access are found to be degrading factors in some clusters. Policy implications are: Need for political measures is strongest in “intensive, livestock”, “expanding cropland, humid”, and “mountain areas” patterns. Efforts to combat water erosion should focus on poverty reduction and measures to relieve pressure on land. In marginal regions such measures are of special importance. The results do not suggest an easy solution. However, if taken seriously, successful development efforts could lead to both improved welfare and protection of soils.

Keywords: Asia, GIS, policy issues, soil degradation

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Is Socioeconomic Development Consistent with the Conservation of Livestock Biodiversity?

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In the developing world, livestock production is increasing in order **(a)** to supply households (mainly urban) who can afford to buy animal products, and **(b)** to contribute to food security and rural development.

To consider the threats and opportunities facing livestock biodiversity, it is helpful to consider separately the consequences of policies aimed at increasing food availability, and those aimed at increasing food security.

Threats from requirement for increased food availability

1. Intensification following developed-world models
2. Standardisation of marketed products
3. Institutional bias
4. Shift in favoured species

Threats from requirement for increased food security

5. Standardisation of marketed livestock
6. Social equity and changing employment patterns
7. Provision of credit

Opportunities from requirement for increased food availability

8. Climate change and emergent diseases
9. Use of traditional breeds in sustainable crossbreeding
10. International trade in animal genetic resources
11. Internalisation of environmental costs

Opportunities predicted from requirement for increased food security

12. Past experience with livestock projects
13. Lower dependence on veterinary and nutritional inputs
14. Entry points for wider programmes
15. Appreciation of value of local and indigenous knowledge
16. Disaster or reconstruction aid
17. Biodiversity issues in natural resource management

The scientific community must **(a)** help to formulate policy by clarifying the issues involved and **(b)** promote research that can remove constraints on sustainable production. Two possible topics are, development of the concept of genetic impact assessment and exploration of its relevance to policy; and design of crossbreeding schemes that enable livestock biodiversity to be exploited in a sustainable manner.

Keywords: Livestock biodiversity

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Impact of the Use of Exotic Compared to Local Pig Breeds on Socio-Economic Development and Biodiversity in Viet Nam

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Viet Nam owns a wide variety of local pig breeds, being long time the basis of pig production. The present pig population was strongly influenced by an influx of exotic pig breeds.

This contribution describes Vietnamese local breeds, their origin and distribution, and assesses the influx of exotic pig breeds to Viet Nam. Data were collected between 10/2004 and 2/2005 through literature reviews/key person interviews, within a global study on status, impacts, and trends from the exchange of breeding animals, implemented by the Institute of Animal Production in the Tropics and Subtropics, University of Hohenheim, commissioned by BMZ/GTZ, and supported by FAO.

The Vietnamese pig population developed under the influence of migration, trade, and colonisation from neighbouring China, Laos and Cambodia. In the 20th century, the Vietnamese government promoted specifically higher yielding local breeds, the Mong Cai breed prevailing as major sow line. Composite genotypes evolved, through uncontrolled crossbreeding/scientific research. Exotic pigs have been introduced from the US and Europe since the 1920s. Over time, gene flow was driven by French colonial rulers, American armed forces, the socialist government, and since 1986 (economic liberalisation) commercial breeding companies and developmental projects. Decentralisation of the breeding system together with a developed Artificial Insemination network supported the spread of exotic pigs especially at smallholder level.

Crossbreeding and replacement caused a severe decrease of indigenous breeds, in 2002 accounting for 26 % of the pig population. Of 14 local breeds, 71 % were in vulnerable/critical state or facing extinction.

Local breeds produce in low-input systems, fulfilling multiple functions for smallholder households. They yield lower performances than exotics, but require lower production inputs, and have favourable adaptation traits. The genetic distinctness and greater genetic heterogeneity of Vietnamese opposed to European breeds was shown. Local breeds are a source of promising alleles, possibly significant for future genetic improvement and of unpredictable economic value.

Results show that gene flow has been a net influx of exotic pigs to Viet Nam, accelerating in the last decades. The impact of a possible loss of local breeds on biodiversity, and on the socio-economic situation of resource-poor smallholders is discussed.

Keywords: Biodiversity, gene flow, local pig breeds, smallholder production, Viet Nam

Determining Right Priorities for Conserving Farm Animal Genetic Resources — The Case of Borana Cattle in East Africa

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Borana cattle have their origin in Southern Ethiopia and Kenya where they are guarded by the Borana-Oromyfa clans in the harsh environment of the Borana plateau. Borana cattle are also the main source of the livestock-keepers' income and the local people's cultural identity is formed on the husbandry of these animals. Nowadays the existence of this breed and hence its cultural heritage is threatened due to intensifying crossbreeding among different breeds and eventually dwindling records of pure Borana animals. Conservation of the pure Borana genetic resources is important for future use and enhancement of biodiversity, but financial aid for conservation initiatives is scarce. This study addresses two crucial topics in conservation theory: the question of "which" Borana animals should be conserved and hence deserve priority in funding, and the question of "who" should conserve them.

370 livestock-keepers on the Borana plateau were selected for conducting semi-structured questionnaires and choice experiments. The models were then analysed using NLOGIT 3.0. The first question is driven by the fact that currently three different subtypes of the Borana breed are known and kept on the Borana plateau. Appropriate allocation of funds among them must take place according to their economic and genetic values. Economic values are determined by applying a discrete choice analysis estimating the livestock-keepers' willingness to pay and relative preferences for different attributes of the Borana cattle. Genetic values depend on two factors, namely the level of extinction probability and the level of marginal genetic diversity. Both factors are incorporated into the model and together with economic values form the total value of Borana cattle and its subtypes.

The question of "who" should participate in conservation initiatives requires the consideration of individual livestock-keepers' characteristics into the model revealing heterogeneity in livestock-keepers' preferences and willingness to pay for different cattle attributes. A random parameter logit model is used seeking to establish different groups of livestock-keepers that can be targeted for conserving Borana.

Results suggest that Borana cattle are particularly important because of their adaptability and performance attributes and that their values vary significantly among livestock-keepers with different production systems and in different areas.

Keywords: Animal genetic resources, choice experiment, East African Borana cattle, random parameter logit

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Gene Flow in Animal Genetic Resources — A Study on Status, Impacts, Trends from Exchange of Breeding Animals

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Data on exchange of livestock genetic resources are compiled to create an information basis for future national, regional and global negotiations on trade agreements for breeding stock. The study is commissioned by BMZ/GTZ. FAO is implementing partner. International statistical data on movement of breeding stock are poor and difficult to obtain. Descriptive analyses are based on qualitative and quantitative data in publications, project reports, national and international statistics. Complementary information was collected from experts that supplemented, crosschecked and validated results. The report comprises of a global study and case studies for cattle, sheep, goats and pigs.

Human migration led to breed diversity through domestication and breed formation. Exchange of stock was an important tool in breed formation and development. Advanced mobility, reproduction biotechnology and modern breeding methods enhanced gene flows since the 20th century. Concentration on a few successful breeds led to their worldwide expansion at the expense of local breeds. This trend results in loss of biodiversity. However, transfer of breeds that are suitable for respective production systems benefits farmers economically. Veterinary regulations increasingly restrict transfer of breeding stock. While in more sophisticated breeding systems after sales benefit sharing is increasingly practised, a single and final payment is still the rule in most circumstances. In most developing countries influence of breeding organisations and governments on animal trade is limited.

Movements of breeding animals are best documented in cattle due to early establishment of breeding organisations. Main directions of cattle transfers were initially east-west and north-south but more recently west-east as well as south-south movements gained importance.

Sheep and goat gene flows are relatively small in number and extent. Transfers are mainly conducted by private initiatives of single breeders, but breeding organisations with data on movements are rare. As an example, the history of gene flow of Awassi sheep from Israel is followed in detail.

Data on recent transfer of breeding pigs are difficult to obtain because of the structure of modern pig breeding with main emphasis on hybrids and the leading role of few breeding companies in worldwide distribution of pigs.

Keywords: Animal genetic resources, biodiversity, breeding animals, gene flow, live animal trade, poverty reduction, semen trade

The LIFE-Method: A People-Centred Conceptual and Methodological Approach to the Documentation of Animal Genetic Resources

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Comprehensive documentation of existing livestock breeds is a prerequisite for measures aimed at the sustainable use and conservation of domestic animal diversity. Appropriate conservation policies can only be developed, if the social, cultural and production contexts of livestock breeds are fully understood. Conventional documentation methods focus on population, phenotypic and production characteristics, and are based mostly on quantitative data and measurements. By looking at a breed from an outsider's or scientist's perspective they neglect to consider the priorities and concepts of its keepers and do not grasp the livelihood contribution of a breed that goes beyond production of quantifiable outputs. The resulting information therefore does not reflect the situation from the perspective of the farmer for whom cash products are often of secondary importance. Especially in marginal and remote areas, breeds generate an array of benefits that are more difficult to grasp and quantify than outputs of meat, milk, eggs, and wool. These include their contribution to social cohesion and identity, their fulfilment of ritual and religious needs, their role in nutrient recycling and as providers of energy, and their capacity to act as savings bank and insurance against droughts and other natural calamities. The LIFE-method was developed by a group of NGOs in India in order to document breeds from a people-centred perspective. It captures important characteristics of traditional breeds that were previously ignored and records breeds based on the knowledge, concepts and priorities of the associated communities. Most significantly, it comprehends breeds as products of social networks. This approach consists of a conceptual framework and employs "participatory" methods, instead of pre-determined forms. It has been tested with large animals, such as cattle, buffalo, and sheep, and mainly in pastoral contexts. This paper will present several examples of information collected by this new methodological approach.

Keywords: Animal genetic resources, participatory methods, livelihoods, documentation, sustainable use

Water, Soil and Irrigation

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Social aspects of irrigation designs: the interaction of water, technology and people

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Irrigation — the movement of water by people for crop production, through infrastructure and human endeavour — requires consideration of social as well as technical dimensions of water control. The design of an irrigation system involves the conscious and intuitive ordering of knowledge, infrastructure and management institutions for water delivery, according to principles, practices and priorities decided by society — and not only the application of science to water conveyance and crop production. Irrigation is thus not only socially constructed in the choices of infrastructure and institutions, but also in its social requirements of use and social effects. There are conceptual frameworks that help reflect on these social dimensions at system and farm level. These can help avoid design approaches that ignore social dimensions or treat them as a black box. There have been shifts in objectives and principles shaping the design of irrigation systems. In the past, irrigation systems have had socioeconomic objectives in water supply, for settlement, food and livelihood security and economic development. There are now new techno-economic objectives driving new irrigation designs, consequent to concerns for changing water supply, production and management options — although systems must still meet objectives of value and profitability for farmers. New objectives influencing designs include: improved management performance; water and land conservation; increased flexibility in supply; better hydraulic and environmental control; and greater uniformity in water application and production, as discussed in this meeting. Understanding the social dimensions of these new design concerns alongside technical possibilities can help users and engineers negotiate for better design outcomes, and prevent false expectations of change or conflict.

Keywords: Irrigation systems, water supply

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Water Use and Drought Stress Reaction in Greenhouse Split-Root Lychee

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Lychee (*Litchi sinensis*) is one of the predominant fruit crops in upland areas of Northern Thailand, where it is produced during dry season under irrigation. As water is an increasingly scarce resource in the hillsides, strategies for more efficient water use are fundamental for sustainable increasing agricultural production. Partial Rootzone Drying (PRD) is a novel irrigation technique which is based on the induction of changes in the plant hormonal balance. By targeted withdrawal of irrigation water an increased level of Abscisic Acid (ABA) is obtained, which makes the plant reduce its stomatal aperture and thereby decrease water consumption. The reduction in biomass production is directed to reduce vegetative growth, while yield is widely unaffected.

To test the response of lychee to PRD, 30 two years old trees were exposed to different irrigation treatments under controlled conditions. The trees were grouped in four groups with the following irrigation treatments: a.) full irrigation, as previously measured b.) PRD with 50 % of full irrigation, changing the irrigated sides every two weeks c.) 50 % of full irrigation, evenly distributed and d.) no irrigation. The trees were watered in a three days interval. Water consumption was measured gravimetrically. Evaporation was prevented by covering with a plastic sheet. Soil moisture was controlled by use of TDR probes. Twice a day (morning and afternoon) the stomatal resistance has been measured with a transportable Porometer AP4 (Delta T, Cambridge). At three dates leaf samples have been tested on there ABA content.

After three months of experiment no significant differences could be found in the response to drought stress of PRD and deficit irrigated trees. After two weeks of undergoing the same treatment, stomatal resistance and water consumption did not vary significantly. Also the levels of ABA in the leaves did not differ among the stressed treatments. As the response to drought stress might considerable vary for bearing trees, field experiments in Thailand are projected to give additional information about the yield response of lychee to deficit irrigation.

Keywords: Abscisic Acid (ABA), irrigation, partial rootzone drying (PRD)

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Improvement of Water Harvesting and Anti-Erosive Cultural Practices for Sustainable Rainfed Multiple Crop Production on Sloping Land

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This experiment aims to evaluate the effects of water harvesting strategies and anti-erosive cultural practices on the improvements of soil and water conservation for sustainable rainfed multiple crop production on sloping land. The field trials (Sites A and B) in Borkrai Village, Northern Thailand, consisted of 12 sub plots (5 × 30 m) each site, with rotations of maize (*Zea mays*) followed by upland rice (*Oryza sativa*) and lablab bean (*Lablab purpureous*). The experiment was a completely randomised design (CRD) with three replicates of 4 anti-erosive cultural practices, (i) Conventional contour planting (CP), (ii) Contour furrow cultivation and alley cropping with the hedgerows of mixed fruit trees (CF -AL), (iii) Contour furrow cultivation with mulching and alley cropping (CF-M-AL), and (iv) Conventional contour planting and alley cropping + vetiver grass rows (CP -AL-VG). The measured data were top soil chemical and physical properties, surface runoff and soil loss, 1 m soil water content profile, crop total dry biomasses and yields.

The results obtained from Site A (which were similar to Site B) during the first experimental year are described as follows. (i) CF-M-AL tended to give better soil properties than the other treatments. (ii) The lowest surface runoff and soil loss occurred in CF-M-AL plots (87 m³ ha⁻¹ and 57 t ha⁻¹) while the highest amounts were found in CP plots (132 m³ ha⁻¹ and 315 t ha⁻¹), compared to CF-AL plots (92 m³ ha⁻¹ and 90 t ha⁻¹) or CP-AL-VG plots (97 m³ ha⁻¹ and 189 t ha⁻¹). (iii) The highest amount of mid-dry season soil water contents (1 m soil depth) was obtained under CF-M-AL (165 mm), compared to CP (133 mm) or CF-AL (139 mm) or CP-AL-VG (125). (iv) Maize yields was the lowest under CP (4.32 t ha⁻¹) compared to CF-M-AL (7.20 t ha⁻¹), CF-AL (6.20 t ha⁻¹) and CP-AL-VG (5.87 t ha⁻¹). CF-M-AL gave the highest total biomass yield of maize and lablab beans compared to the other treatments. The results indicated that contour furrow cultivation with mulching (CF-M-AL) was the best while conventional contour planting (CP) was the worst strategy for soil and water conservation, and multiple crop production improvement.

Keywords: Alley cropping, anti-erosive, contour furrow cultivation, multiple cropping, water harvest

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Development of Soil Salinity under Irrigated Land-Use in a Dry Region of Syria

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History shows that in dry Mediterranean regions, the long-term use of saline water for supplemental irrigation is a risky practice. The objective of the investigation was to find, if irrigation with saline water was sustainable under the conditions in the study area. The groundwater had an average sodium adsorption ratio (SAR) of 8.5 and an electrical conductivity (EC) ranging from 2-16 dS m⁻¹. In 1998, samples for the determination of EC were taken from the first meter of soil in 1998. After six seasons, the soil EC near the original locations was measured again. Additional soil EC measurements were made before and after irrigation trials in 2003/04.

Crop rotations and past irrigations were reconstructed together with the water users. These were substantiated using irrigation monitoring and rainfall records. After 6 years, the results for the study area gave no indication of any rise in soil salinity. Possible explanations were: favourable infiltration rates, the occurrence of strong rainfall in winter, changing crop types, changing irrigation methods, and the on-farm rotation of irrigated fields.

Keywords: Electrical conductivity (EC), groundwater, low-rainfall zone, soil salinity, supplemental irrigation, sustainability, Syria

Water-Mediated Discharge of Pesticides from a Sloped Lychee Orchard, N-Thailand

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Fruit cropping is considered to be a sustainable alternative to annual field crops in the mountainous regions of northern Thailand because permanent cultures are less prone to erosion, but little is known about pesticide discharge from Thai fruit orchards. The objective of our study was to investigate water-mediated transport of agrochemicals from a sloped lychee plantation into ground and surface water. Therefore, we installed suction lysimeters, wick lysimeters (both in 55 cm soil depth) and surface runoff collectors in a 10-year-old orchard with grass-covered soil. Water and pesticide fluxes were monitored for 50 days after repeated manual applications of organochlorine and organophosphorous insecticides typically used in lychee production (simultaneous applications of 6 different compounds every 10 days). Despite an inclination of ca.15°, surface runoff and its pesticide load were negligible (runoff <0.05 % of precipitation; pesticide discharge max. $1 \cdot 10^{-4}$ % of the applied amount; malathion). Wick lysimeters delivered water only under saturated conditions (6 of 25 sampling events; 7.2 % of precipitation), maximal pesticide discharge amounted to $6 \cdot 10^{-4}$ % of the applied amount (endosulfan). The suction lysimeters delivered about 70 % of the amount of precipitation. This high proportion indicates that preferential flow is a relevant process of water transport on our research site. Nevertheless, pesticide concentrations in samples from the suction lysimeters were below the limit of detection throughout the experiment. Thus, under the given weather conditions, the pathways investigated in our study do not contribute significantly to pesticide inputs into ground and surface waters. Even an extreme storm event observed in a previous experiment on the same plot translocated only small amounts of pesticides (<2 % of applied). We conclude that pesticides detected in the rivers of our research area will, at least partially, enter them either from land-use systems other than lychee orchards (i.e. crop or flower cultivation) and/or on pathways other than surface runoff and leaching (i.e. volatilisation and re-precipitation and/or spray drift).

Keywords: Fruit orchard, leaching, pesticide contamination, preferential flow, South-east Asia, surface runoff, sustainability

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Non-Invasive Methods in Quality Testing of Fresh and Processed Horticultural Produce

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The final quality of a horticultural produce after minimal and intensive processing is highly dependent on the quality of the product entering the process, on the technology applied, and on the storage conditions. Measuring the product maturity and evaluating the impact of processing technologies on the product quality with respect to its anti-oxidant nutrient content is an important task to determine strategies for quality optimization and monitoring in the frame of a reasonable process management.

New methods are recently evaluated for this purpose taking into account their accuracy and feasibility. In this contribution 3 applications of optical technologies are presented for monitoring the maturity, nutritional value, as well as internal damage of fresh and processed horticultural produce:

- In commercial citrus production the fruits' soluble solids content (SSC) is used for determining the optimum harvest date. NIR spectrometry became recently available for measuring the citrus SSC non-destructively. In the present study, monitoring the citrus SSC was carried out on 8 citrus varieties in a shade house and on the farm by means of spectrometric readings (MMS1 NIRenh., Zeiss, Germany) during the harvest period. Comparing the SSC values from fruit grown on the farm and in the shade house indicate a higher variance in fruit grown unprotected. On the farm, trees planted in sandy soil, more severely suffering from water stress developed fruits with slightly higher SSC in the period reported. Such additional information on the fruit maturity at different locations in the production are valuable for an appropriate harvest management.
- Fluorescence spectrometry was applied for analyzing fluorescent nutrients. Polyphenols, vitamin E, and pro-vitamins were measured in extra virgin olive oil subjected to heat impact. Data acquired by means of conventional chromatographic techniques and fluorescence spectrometry were used to monitor the nutritional damage due to processing. Reproducibility of fluorescence spectrometry applied non-destructively appeared with errors of >15 %. High errors are mainly caused by reabsorbing compounds present in the complex product matrix. Therefore, application of laser-induced, time-resolved fluorimetry is presently studied for optimizing the measuring set-up with respect to characteristic life-times of the molecule under question.

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- Matrix properties of *Lycopersicum esculentum* were analyzed for monitoring the fruit response to sanitizing treatments as high pressure and washing with ozonized water. Physicochemical tissue parameters of tomatoes were measured regarding the spectral reflectance and light scattering behaviour. Readings of light scattering in the tissue provided a sensitive method to quantify the internal damage due to the treatment conditions applied.

Keywords: Citrus production, fluorescence spectrometry, horticultural produce, product maturity, non-invasive quality testing, soluble solids content

Lengthening Storage and Shelf Life of *Uapaca kirkiana* (Muell. Arg.), an Indigenous Fruit to Parts of Africa

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Uapaca kirkiana (MUELL. Arg.) a highly valued wild indigenous fruit species in parts of Africa, is being domesticated to widen its utilisation. Fruit are gathered from the ground when ripe or dislodged when unripe from trees and incubated to ripen them. While the fruit are widely marketed (mostly in informal markets), household utilisation and marketing are limited by a short shelf life of about 3 days for ripe fruit. To investigate ways to increase the storage life of the fruit, we evaluated the influence of storing unripe fruit in a cold room (5 °C), at ambient room temperature (30 °C), or in clay pots (31 °C), on the subsequent softening of the fruit after removal from storage. We also evaluated the effect of keeping ripe fruit on open plates, in polyethylene bags and clay pots, all at ambient room temperature, on weight loss, skin and pulp colour, and soluble solids concentration (SSC). Overall, unripe fruit under cold storage lost less weight and their softening was delayed, thus extending their storage life. In contrast, storing fruit in clay pots advanced and enhanced their softening and subsequent deterioration. Ripe fruit kept in polyethylene bags lost the least weight (10 %) over a 6 day storage period after ripening compared with those on open plates (29 %) and clay pots (22 %). Storing ripe fruit in polyethylene bags maintained a higher proportion (78 %) of fruit with a skin colour rating of fair and good (combined) compared with only 28 % and 35 % of the fruit from plates and clay pots, respectively. The remaining fruit developed a darkened dull skin colour. In addition, 34 % of the fruit from polyethylene bags still had the ideal orange pulp colour on day 6, compared with only 4 % and 0 % for plates and clay pots respectively. The SSC were lowest in ripe fruit kept in the polyethylene bags, this probably being a result of the concentration effects of SSC by greater water loss from fruit on plates and in clay pots. The study has demonstrated the potential for low temperature storage and using polyethylene packaging to lengthen storage and shelf life of fresh *U. kirkiana* fruit, but the possible risk of chilling injury at these low storage temperatures needs to be evaluated.

Keywords: Fruit colour, indigenous fruit, shelf life, soluble solids concentration, storage temperature, *Uapaca kirkiana*

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Evaluation of Mango Processing into Fluid Products for Improved Provitamin A Supply

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Apart from the appropriate process technology, the production of high-quality food equally depends on the selection of the proper raw material. This experience can be particularly exemplified by mango (*Mangifera indica* L.) processing. In this contribution, the influence of proper raw material selection and thermal processing steps involved in small-scale batch and continuous industrial manufacture of fluid mango products on resulting provitamin A values is discussed. The provitamin A value of mango fruits and products is determined by their contents of β -carotene stereoisomers differently contributing to vitamin A biosynthesis.

Concerning the selection of suitable mango cultivars at appropriate processing ripeness, accumulation of β -carotene during postharvest ripening of nine Thai mango cultivars was assessed. The vitamin A potential was evaluated at different ripening stages unequivocally defined by a ripening index. Subjected to the same postharvest ripening conditions, only those cultivars developing a bright yellow-orange mesocarp colouration resulted in high vitamin A values of 892–1573 retinol equivalents / 100 g mesocarp dry weight at their fully ripe stage. Exponential development of mesocarp colour and all-trans- β -carotene levels, respectively, with the ripening index was described for each cultivar, allowing the selection of fruits of high provitamin A values for processing by easily accessible quality parameters.

Modern industrial year-round mango juice production is mostly based on purée intermediates produced during peak harvest seasons. The fruit component in the final nectar usually implies several heating treatments in the form of steam peeling, thermal inactivation of endogenous enzymes prior to enzymatic pulp liquefaction, and pasteurisation of purée and nectar, respectively. However, heat application in continuous processes is restricted to periods below 1 min. In contrast, simple small-scale batch processes at the household level require only the final pasteurisation of the filled product but by heat application for an extended process time. The effects of such thermal treatments on β -carotene degradation and isomerisation were studied by mimicking the processes at laboratory scale and by verifying the observations by stepwise process control at pilot-plant scale. The importance of fluid mango products produced at different scales as provitamin A source was demonstrated. Necessary plant physiological and technological prerequisites were identified.

Keywords: Beta-carotene, food quality, *Mangifera indica*, postharvest ripening, process technology

Conception of a Drier for the Semi-Industrial Production of Dried Cassava

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Cassava is a crop that plays an important role in farmers' livelihood and in human nutrition in West Africa. During the last two years, cassava production has increased considerably due to government policy in Benin.

As cassava can not be stored for a prolonged period of time, post harvest losses can make up around 50% of total production. A cassava conservation method is drying. However, traditional drying methods are unsuitable for cassava conservation.

This work aims at evaluating farmers' needs for cassava drying and to conceive a capable cassava drier.

To reach this objective, 1000 commercial producers (men and women based on division of work) have been investigated in two departments of Benin by using questionnaires and focus group discussions. Drying tests have been done with a GEHO drier, a drier built in Hohenheim, which uses both solar and gas energy. Cassava samples were dried during the rainy season and the dry season. Data collected were analysed and will help to design an appropriate local drier.

The investigation made clear that drying comes at second place among cassava production constraints, after the difficulties by the harvest. The results show that storekeepers and consumers have clear preferences for dried cassava, it should be white in colour, and it should be very dry, non-punctured, unsweetened, without bugs, without powder and of a big size.

The work also shows that the maximum quantity of cassava to be dried per investigated farmer is around 7.5 tonnes per season. The dried cassava obtained by the drying tests was highly appreciated by storekeepers and consumers.

The construction of an appropriate drier will help farmers enormously in their cassava processing activities, will reduce post-harvest losses and will therefore help to ameliorate food security in Benin.

Keywords: Cassava, conception, drier, drying, food security,

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Development of a Cassava Peeling Machine

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Cassava (*Manihot esculenta* Crantz), the favoured root and tuber crop of the tropics, is one of the most important energy sources in the human diet in the tropics. It is an important staple food and cash crop that thrives where most other crops fail. Cassava is utilised extensively for human and livestock consumption as well as for other industrial products such as starch. Most of the usages are in processed forms while only a small quantity is consumed directly. However, cassava processing is labour-intensive requiring mechanisation in order to meet up with current demand for these products. One major bottleneck in cassava processing has been cassava peeling, hence the objective of this study was to present a recently developed cassava peeling machine at the Federal University of Technology, Akure, Nigeria. To our knowledge, this is the first efficient cassava peeler in Sub-Saharan Africa. The machine has a capacity of 8 tons/day and performs the dual role of peeling and grating. The cassava peeler consists of a 5 Hp petrol engine, an abrasive drum (150 mm long), frame and transmission system. This prototype has been designed, fabricated and tested in our machine shop and found to be highly efficient. The cost of a single unit (prototype) was estimated at about 750 US Dollars. The machine is required in the production line of the following products: cassava grit, gari, cassava flour, cassava chips and pellets, lafun, pupuru, and starch. The result of this study has positive implications on food quality and security as well as on economic empowerment of the rural poor of the developing countries in the tropics where cassava products are becoming increasingly important.

Keywords: Cassava, chips, lafun, peeling machine, pupuru

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Agroforestry Modelling — Managing Complexity

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Agroforestry has been promoted for its ecological benefits to farmers, such as sustained production, improved resource use efficiency, and soil conservation. However, farmers' perceptions of costs and benefits often differ from those of external researchers. Labour has a significant opportunity cost even for the poorest farmers, and so return to labour can be more important than return to area or to fertiliser. Other costs that are commonly undervalued by external researchers include risk, learning, and the development of new institutions such as trading networks and advisory services. There is growing recognition of the external benefits of agroforestry such as conserving biodiversity, reducing downstream flood risk or sequestering carbon. Efforts to monetise these benefits and pass payments back to farmers are welcome, but are unlikely to be successful unless the discrepancy between external perceptions and true or farm-gate costs and benefits is addressed. Even the farm gate may not be close enough * patterns of control of resources within farms vary and need to be understood. Farms themselves are heterogeneous. Modelling can help refine agroforestry techniques for particular niches within this complex social and ecological landscape. Modelling aimed at improving agroforestry systems needs to incorporate state-of-the-art knowledge about biophysical processes. Models must also generate indicators relevant to decision-makers at different scales. This depends on good communication among modellers, experimenters and farmers, so that adequate but measurable parameter sets can be developed. Communication is greatly aided by involving specialists, by imposing strict modularity when developing models, and by striving for transparency.

Keywords: Agroforestry, modelling

Quality Management Practices in Cocoa Production in South - Western Nigeria

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The main objective of this study was to investigate quality management practices in the major cocoa production areas of Nigeria. Socio-economic surveys covered resource quality, agronomic practices, and constraints to agricultural production, whereas soil sampling and analyses were carried out to assess contribution of soil to yield. Farm budget analysis was used to determine the profitability of the two major management options of sampled farmers.

Linear multiple regression was used to relate biophysical and agronomic data to cocoa yield. Owing to high level of multi-collinearity, independent variables were reduced to six which are organic C, age of farm, plant density, proportion of dormant plants replaced, crop variety and ECEC. Among the variables in the model, two (organic C and age of farm) were negatively related to cocoa yield, whereas other variables were positively related to cocoa yield. However, soil variables were not significant to the model ($p > 0.05$), whereas three management variables (plant density, proportion of dormant plants replaced and crop variety) were significant ($p < 0.1$). All the variables explain 97 % of the variability of yield and the model can be used to predict yield at 99 % confidence level. Results indicated variability in yield across the three main locations studied. The highest yields were obtained in areas where farmers have access to training in management practices.

Soils of the three locations were not significantly different from one another in terms of chemical properties. This probably reflects similarity in the parent materials from which the soils have developed.

Farm budget analysis revealed that minimal management involving fertiliser and pesticide use was less profitable than extensive management.

For sustainable cocoa production in the study areas, a high premium should be placed on the quality of cocoa product for export.

Keywords: Cocoa production, farm budget, linear multiple regression, management, quality

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Building Opportunities for Small Holder Farmers to Commoditize Indigenous Fruit Trees and Products in Southern Africa: Participatory Selection, Propagation and Cultivation

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Many rural households rely on indigenous fruit trees (IFTs) as sources of cash and subsistence in Southern Africa, but until recently there has been little effort to cultivate, improve or add value to these fruits. Since 1989 the International Centre for Research in Agroforestry, ICRAF (also known as the World Agroforestry Centre), initiated research-and-development work on indigenous fruit trees in five countries in southern Africa. A participatory approach was used at all stages of their domestication, product development and commercialisation. Species preference by diverse groups of users varied. From this information, country-specific priorities were identified. Using vegetative propagation, clones are being developed from superior trees within the very diverse wild population. These clones have been established in trial orchards for selection of true-to-type, high yielding cultivars with large, sweet fruits, and pest tolerance. Multi-locational provenance trials showed that some Mozambique provenance of *Sclerocarya birrea* grown in Malawi are prolific and early fruiting. With clonal propagation, preliminary results indicate that the long juvenile phase of *Uapaca kirkiana* can be shortened from 12–16 years to less than four years. An ex ante impact analysis based on ‘real options’ theory, indicates that a combination of a robust technical change (improvement) and decrease in abundance of fruits in the forest will create incentives for farmer-led investment in the cultivation of IFTs, as an alternative to wild fruit collection. In Zimbabwe, the returns to family labour of collecting wild fruits are two to three times greater than other farming activities, especially for *P. curatellifolia* (4.8 times). It is anticipated that domestication will further increase the returns, Results from surveys of nursery operators, post-harvest research, land tenures and pest and disease management are also discussed in this paper.

Keywords: Clonal development, livelihoods, post-harvest, propagation, wild fruits

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Dynamics and Diversity of Insect Populations: Approaches for Sustainable Land Use in Lychee Orchards of Northern Thailand

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In lychee growing systems in northern Thailand, pesticides are frequently used by local farmers to prevent negative impacts of pest arthropods on fruit production. Considering the health and environmental hazards of synthetic pesticides, their constant and unreflected applications precludes attempts to establish a sustainable management of the lychee growing systems. Therefore, a substitution of pesticide application is required. However, it is well-known that the massive use of broad-spectrum insecticides leads to shifts in the composition of the arthropod community, i.e. not only numbers of pest insects are reduced, but also beneficial arthropods such as pollinators, predators and parasitoids. As a component of the agrobiocoenosis, beneficial arthropods provide a wide range of advantageous biological services including the suppression of pest insect populations. Conducting an intrinsic system approach, the present study focuses on the evaluation of the habitat requirements of beneficial insects and pests, which includes field scale and landscape scale approaches.

On the field scale, the objective is to improve the habitat conditions for beneficials with the specific focus on the role of additional resources provided by plants of the ground cover vegetation. By this, an increase in abundance and effectiveness of the beneficial species is expected, which in turn results in reduced pest populations. In a lychee orchard, four different combinations of two pesticide (with vs. without) and mowing (monthly vs. once per year) treatments of the attendant ground cover vegetation were studied. Effects of the four different combinations on the presence, density and diversity of beneficial insects are obtained.

On the landscape scale, the influence of the functional landscape coherence on the constitution of pest and beneficial insect populations in the litchi orchard is evaluated in addition. Since adjacent landscape elements are potential colonisation sources and places for refuge, lychee orchards represent open systems. Due to migrating individuals, the condition of pest and beneficial insect populations is affected. Hence, the spatial movement patterns of major pest and beneficial insects between an adjacent forest habitat and the lychee orchard were recorded on the landscape scale. Complementary, the seasonal dynamics of the insect antagonist-complex is documented facilitating alternative pest control measures.

Keywords: Beneficial insects, lychee, migration, pests, sustainable land use

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Modelling Agroforestry Systems in Hillside Cropping of North-East Thailand by Using WaNuLCAS

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In Northeast Thailand, soil erosion by water is a severe problem in uplands, contributing to low productivity of hillside cropping systems and a poor food security. Agroforestry systems may play an important role to control water induced soil erosion. However, experimental testing of their potential application domain and design is costly and time consuming. Modelling can be used to investigate these systems relatively quickly and at relatively low cost. The Water, Nutrient and Light Capture in Agroforestry Systems (WaNuLCAS) model was developed to deal with a wide range of agroforestry systems with minimum parameter adjustments. Examples for applications are crop rotations, hedgerow intercropping systems at different hedgerow spacings and pruning regimes, crop-fallow mosaics and parkland systems with a circular geometry. Safety-net function of deep tree roots, lateral interactions on flat or sloping land, tree-soil-crop interactions across a rainfall gradient, water and nutrient use efficiencies of agroforestry systems can also be tested. However, models must first be validated to assess satisfactory simulation of the target systems. Climatic, edaphic, crop and tree growth data collected from an erosion trial at Ban Bo Muang Noi, Loei province were used to test the model sensitivity for the northeast of Thailand. Maize yields and tree growth were quite well predicted by the model and corresponded to real-world observations. However further model validation is required before any soil, climate, tree and crop specific model prediction can be made as the predicted data's goodness of fit with the experimentally observed data was low. Possible entry points are pedotransfer functions and other default settings.

Keywords: Erosion, fruit trees, hedgerow, maize, soil conservation

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Water Resource Allocation: Productivity, Equity, and Environmental Impacts

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As water scarcity and competition over the resource increase, there is a need for greater attention to water resource allocation—the assignment of water rights and decisions on when, how, and where water will be delivered. This goes beyond the focus on the physical process of delivering water, to deal explicitly with decisions on the use of water in different sectors, and leads to a greater emphasis on the rights and incentives of water users. This paper discusses the relative strengths and roles of state, user-based, and market allocation mechanisms in shaping the productivity, equity, and sustainability of water resource use, as well as the potential and challenges in reforming water rights and allocation mechanisms.

Most attention has been on water quantity allocation, but water quality is emerging as one of the most significant problems in water management. Most water allocation institutions are not well equipped to handle water quality. Incorporating water quality considerations into definitions of water rights is one of the major challenges for water resource management in this century.

Keywords: Water quality, market allocation

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Modelling Regional Evapotranspiration in the Volta Basin, West Africa: A Test of Complementarity Relationship Hypothesis

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Engineers, water managers, agriculturists and hydrologists continue the search for simple but robust or novel methods to estimate evapotranspiration rates, for proper managements of water resource at both local and regional scales, using only standard meteorological parameters obtainable from synoptic weather stations. Models based on Bouchet's complementarity relationship hypothesis are examples of such models that could bypass or incorporate the complex feedback mechanisms existing in the soil-plant-atmosphere system, and are hence useful in that respect. The complementarity relationship hypothesis was, therefore, tested in the Volta Basin using the Advection-Aridity (AA) approach. This model is based on conceptual symmetry between actual (ET_a) and potential (ET_p) evapotranspiration over a large area of regional extent. The AA model was reformulated to make it suitably applicable in the Volta Basin. Recalibration of wet environment ET (ET_w) and reparameterisation of wind function yielded a marked improvement of the AA model performance. Seasonal surfaces of ET_p and ET_w follow the gradients of available energy and moisture, respectively. The monsoon (convective) clouds and harmattan play significant roles in attenuating solar radiation which, coupled with seasonal changes in surface albedo, influence evapotranspiration processes in the Basin. The good performance of the improved AA model compared to ET_a output from a regional circulation model (MM5) indicates the utility of models based on Bouchet's complementarity relationship hypothesis in regional ET studies for providing independent estimates of actual evapotranspiration. Modelling of evapotranspiration investigated in this research provide relevant information that can be integrated with other data for sustainable agricultural water management, eco-hydrological modelling, and in the study of climate effects of land use/land-cover change in West Africa.

Keywords: Advection-Aridity model, complementarity relationship hypothesis, regional evapotranspiration

Water, Salt, Cotton and Soums: Shedding New Light on the Aral Sea Problem

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The Aral Sea, once the fourth largest lake in the world, has lost ninety percent of its water volume, due to continuous withdrawal of river water for irrigation from its two main tributaries. This is due to the extensive irrigation systems build up during the Soviet era for cotton production. Today, the region is characterised by water wastage, soil salinisation, and economic inefficiency. However, providing solutions for the “Aral Sea Syndrome” (WBGU) is not easy. Quick assessments are likely to get it wrong. To improve the efficiency and sustainability of water and land use as well as the living conditions of the population in the region, an integrated approach is needed which simultaneously addresses the ecological sustainability of the agricultural production system, its economic efficiency, and the political and institutional arrangements required to make improved systems work. The Centre for Development Research (ZEF) of the University of Bonn has, in close consultation with its national and international partners, designed an interdisciplinary, application oriented research program. The aim is to provide appropriate regional development concepts for sustainable, efficient resource use. The 10-year programme started in 2001 with a philosophy of a long-term participatory commitment and a strong human capacity building component. Particularly the training of young Uzbek academics in their role of future decision-makers in the region has a high priority. The research programme is carried out in the district of Khorezm in Uzbekistan, a model region where solutions for the Aral Sea Basin are being tested.

At present, the first phase, that of data assessment, has been finished. A closer look at the data from agronomic, ecological, economic and legal-institutional research reveals that a careful problem identification and description is needed before sound strategies for remediation can be devised. Several of the widely held basic assumptions about the problem complex in the region are wrong. The presentation gives insight into some of the findings and how they contribute to develop a better, more sustainable, stakeholder-driven approach to improve land and water management in the Aral Sea Basin.

Keywords: Central Asia, desertification, irrigated agriculture, land use and cover change

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Economic Aspects of Water Management in the Drâa Region, South-East Morocco

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The Dâa region in southeast Morocco is characterised by very low rainfall, which makes irrigation mandatory for agricultural production. Water for irrigation is mainly delivered by the Drâa river and its tributaries and, to a lesser extent, from groundwater. Moreover, Ouarzazate, the most important city in the region, with its growing population and tourism activity is also dependent on water from the Drâa catchment. Competition between the main water user agriculture and other water users (households/industry including tourism and hydropower generation) is about to increase in the future, as water supply not only from the rivers originating in the High Atlas possibly declines due to climate change but also groundwater availability. While agricultural water needs will largely remain stable, there is growing demand for drinking water as a consequence from population growth and urbanisation, easier access to the public supply network, and an increasing number of tourists.

An integrated modelling approach involving hydrologic, agronomic, and economic components is used to simulate different water management regimes for the region. The model that has been chosen for the calculations and simulation is based on the River Basin Model developed by IFPRI (Washington D.C.). Simulations have been carried out under special consideration of climate change scenarios for the year 2020. As a consequence, the frequency and duration of dry periods over several years will increase and require adjustment processes in the water management of the region. Results suggest that agriculture will remain the biggest water user in the basin, but also that an increased frequency of dry years will require the introduction of water-saving technologies. Drinking water availability will not be severely affected by droughts as long as the willingness of urban dwellers to pay for water remains much higher than the marginal value of water in agricultural production.

Keywords: Integrated modelling, Morocco, water management

An Enduring Match? Livelihoods, Conservation, and Payments for Watershed Services in China's Upland Areas

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Upland agriculture and watershed conservation are often juxtaposed in China's sustainable development discourse. Intensive upland agriculture sustains the livelihoods of a majority of China's poorest farming communities, but is perceived as environmentally destructive. Deteriorating watershed quality has prompted efforts to convert agricultural land to forest and grassland, which reduces farmers' productive land. Resolving the impasse between upland food security and rural development, on the one hand, and the need to control watershed degradation, on the other, has become one of China's most pressing development challenges.

More recently, efforts to intertwine upland development interests with downstream conservation priorities have taken a new form. Recognizing farmers' lack of conservation incentives, government agencies and industry groups in China have begun to experiment with innovative payment schemes that attempt to offset farmers' opportunity costs for taking land out of agricultural production. These schemes range from national (e.g., the Sloping Land Conversion Program) to catchment (e.g., hydropower station-community agreements) in scale.

This paper provides an overview of the promise and pitfalls of payment mechanisms for watershed services in China's upland areas, drawing on case studies from several provinces. Although preliminary surveys and experience with actual arrangements have demonstrated their potential in China, payment schemes are regularly hindered by a lack of the awareness, market infrastructure, and institutional support necessary for their success.

The stakes are high, and continued experimentation and research is needed. Mechanisms that appropriately reward upland farmers for conservation provide an enduring match between upland development interests and watershed conservation. Failure to provide adequate rewards threatens farmers' food security and livelihoods, and consequently the viability of conservation programs.

Keywords: China, payment for environmental services, upland agriculture, watershed conservation

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Phenotypic Plasticity of Crops and Adaptation to Stress Environments

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Adaptation of crops to stress environments is mostly seen as a function of physiological tolerance capabilities, enabling the plant to continue growing despite a stress condition. Osmotic adjustment is one such mechanism. Frequently more important, and more accessible to breeding, are constitutive avoidance mechanisms residing in the plant's body plan, such as deep root systems, that reduce exposure to stress factors. Much less understood is the contribution of phenotypic plasticity to agro-ecological adaptation. Phenotypic plasticity is the ability of the plant to adjust its morphology, architecture and phenology to environmental conditions in the course of its ontogeny. The result is an infinite number of different phenotypes that can be produced by a given genotype. This paper presents ongoing, experimental and modelling research on adaptive morphogenesis. The interaction between environmental stimuli (such as photoperiod), physiological stress conditions (such as phosphorus deficiency) and competition among sinks for assimilates is discussed using oil palm, sorghum and rice as examples. The paper proceeds with the presentation of a new modelling approach called EcoMeristem, which flexibly builds plant architecture, and simulates resource use and stress conditions, on the basis of genotypic reaction norms. At the core of this approach are the meristems, capable of sensing metabolic and environmental signals, and adjusting structural growth to these signals. The authors conclude with an outlook on future applications of this model in crop breeding, functional genomics and development of improved plant type concepts for stress environments.

Keywords: Osmotic adjustment, EcoMeristem

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Boron Distribution Shows Sodium Distribution in Rice Leaves to be Independent of Transpiration

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Rice grown under saline conditions takes up sodium relative to its water use. Earlier work found higher concentrations of sodium in the stem tissues than in the leaves, although the leaf sodium load was thought to be correlated with transpirational water loss. Since the stems are bulk leaf sheaths, the question remained if we observed an artefact or a preferential retention of sodium in the leaf sheaths. Sodium, like boron, is translocated acropetal with the transpiration stream and should, just like B, which is not phloem mobile in rice, accumulate at the end points of transpiration i.e. in the leaf blades. In a hydroponic system, two lowland rice genotypes were subjected to two levels of salinity (0 and 60 mmol). Four times, in intervals of ten days leaves were sampled in the order of appearance, separated in blades and sheaths, and analyses for Na and B content. Cumulative transpirational water losses were calculated for individual leaves based on leaf area and transpiration measurements. Genotypes differed in sodium and boron uptake as well as water loss. In all cases total Na and B content was linearly correlated with water loss. B accumulated almost exclusively in the leaf blades, whereas Na accumulated preferentially in the leaf sheaths resulting in low Na contents in the leaf blades of the tolerant genotype and a 50 % share of Na in the leaf blades of the sensitive genotype. Retaining large shares of the Na taken up in the leaf sheaths is an important tolerance mechanism as it protects photosynthetically active leaves blades from salinity damage. In rice, B distribution can be used to determine the amount of water loss and the site at which it occurs.

Keywords: Boron, distribution and uptake, leaf development, potassium, rice, salinity, sodium, transpiration, water loss

Development and Characterisation of Virus Resistance in Cassava Against Cassava Mosaic Viruses

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Cassava production in Africa is seriously hampered by the occurrence of a number of different whitefly transmitted viruses causing mosaic diseases and leading to serious decline of the crop and drastic yield reductions. The typical viruses of cassava have diverse genomes are constantly evolving and can occur in single and in mixed infections often leading to complete loss of the harvest. Host plant resistance is to date the sole and most dependable approach to combat the disease. Several cassava genotypes have been found with a high degree of natural resistance against cassava mosaic viruses in the field. To test the spectrum of resistance against viruses occurring in diverse geographies in Africa, we have made an inventory of all major viruses occurring in different cassava growing regions, characterised their genomes and assessed variability and disease phenotypes. Cassava breeding lines were biologically inoculated with cloned viruses to cause infections with all viruses in single or in mixed infections allowing screening for resistance under laboratory conditions. With this, infections in cassava rated highly resistant under field conditions was reached, however, after initial virus replication and symptom development, plants recovered and virus infections were down regulated and then aborted. In several breeding lines, resistance was maintained against a number of viruses while resistance breakdown was also found in cassava clones. This was most severe in plants lines where cassava mosaic mixed virus infections were introduced. Screening for resistance in cassava under laboratory conditions permits the early identification of promising breeding lines, the exact determination of virus resistance characteristics, to define the resistance/tolerance status and to deploy cassava lines into geographic horizons with known virus resistances. The development of resistance in cassava against Cassava mosaic viruses will be discussed.

Keywords: Cassava mosaic virus, cassava resistance, diversity, resistance screening

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Soil Amendment with Silicon and Bacterial Antagonists Induce Resistance Against Bacterial Wilt Caused by *Ralstonia solanacearum* in Tomato

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In tomato plants grown in hydroponic culture, the incidence of bacterial wilt caused by *R. solanacearum* race 1 was significantly reduced by silicon amendment in tomato genotypes L390 (susceptible) by 26.8 % and King Kong2 (moderately resistant) by 56.1 % compared to non-treated plants. However, wilt incidence in silicon-treated plants of genotype L390 reached 100 % at 13 dpi, while in genotype King Kong2, plant death was retarded by 6 days, with 20 % reduction of final wilt incidence. Bacterial numbers were significantly lower in silicon-treated compared to non-treated plants in King Kong2 at 2 dpi in midstems and in all organs at 5 dpi, and in Hawaii 7998 (resistant) in all organs at 2dpi. Differences between genotypes were obvious on mid-stem level, where bacterial populations were generally significantly lower compared to roots. Increased tolerance was observed in genotypes L390 and King Kong2 with silicon treatment. Trials in substrate-grown plants confirm the symptom-suppressing effect of silicon. Silicon accumulated in roots and was low in stems and leaves. Inoculation with *R. solanacearum* did not significantly affect silicon uptake and distribution. Negative correlations between root silicon content and bacterial numbers of midstems in genotypes Hawaii 7998 and King Kong2 suggested an induced resistance.

Treatment of tomato with bacterial antagonists reduced disease incidence by up to 68 %. Immunohistochemical studies show changes in cell wall composition in pathogen-inoculated, silicon-amended and also antagonist-treated plants compared to control plants. Indications for an influence of host genotype and silicon treatment on the phenotypic conversion of *R. solanacearum* from fluidal to non-fluidal colonies in planta were observed.

Keywords: Bacterial wilt, IPM, tomatoes

Biological Control of Aflatoxin Contamination in Maize in Africa

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Aflatoxin contamination of maize, the major cereal in African diets, is a major risk for health and well being of African people, primarily children. Aflatoxin-producing fungi *Aspergillus flavus* and *A. parasiticus* can infect grains from pre-harvest stages in the field through to post-harvest stages in the stores. Based on past work by IITA and our collaborators, several pre- and post-harvest strategies are being tested to reduce risk of aflatoxin contamination. One of the management strategies being developed is biological control using the competitive exclusion mechanism, which has been successfully implemented on cottonseed in Arizona. Natural population of *A. flavus* consists of toxigenic strains that produce copious amount of aflatoxin and atoxigenic strains that lack the capacity to produce aflatoxin. In the competitive exclusion mechanism, introduced atoxigenic strains out compete and exclude toxigenic strains from colonizing grains thereby reducing aflatoxin production in contaminated grains. We have collected more than 4200 isolates of *A. flavus* from different agroecozones in Nigeria to identify atoxigenic strains. Until now, we have identified about 50 candidate atoxigenic strains out of 1500 strains screened so far. Twenty-four of these atoxigenic isolates have been tested under field conditions in Ibadan, Nigeria to identify a few effective strains that can exclude toxigenic strains. These atoxigenic strains are being evaluated for a set of selection criteria to further narrow down the numbers to a few for further use in biocontrol field experiments. One of the important selection criteria will ensure that the candidate atoxigenic strains belong to unique vegetative compatibility groups (for which testers have been developed) that are unable to produce toxigenic progenies in the natural environment. Propensity to multiply, colonize and survive are other selection criteria to make sure that few reapplications will be required once the atoxigenic strains are introduced in the environment. Environmental safety of most promising atoxigenics would be also evaluated. Research to develop atoxigenic strains is resource intensive and will further require downstream development activities. Nevertheless, biological control holds promise of offering a long-term solution for reducing aflatoxin contamination in maize.

Keywords: Aflatoxin, biocontrol, competitive exclusion, maize, Nigeria

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Why Biodiversity Matters? — Messages of the Millennium Ecosystem Assessment

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“Biodiversity” is an evolving concept rather than a stationary entity that can be precisely defined. Different interpretations of the concept can lead to confusion in understanding scientific findings and their policy implications. The “public image” of biodiversity is that of something “nice” to be enjoyed in nature reserves, or biodiversity is attributed an “intrinsic value” for which humanity has moral obligations. But the term has been coined to distinguish it from “biota” for highlighting that all species are jointly involved in the earth’s processes that support human life. These processes hold together the global ecosystem in which people live. Thus, ecosystems’ functions serve people (“ecosystem services”) and the *diversity* of organisms on earth is involved in the provision, maintenance and sustainability of a *diversity* of services; and it is the *difference* between species that is critical for providing the full range of services.

Thus, species diversity is valuable because the presence of a variety of species helps to increase the resilience of ecosystems in the face of a changing environment. And, at the same time an individual component of that diversity is valuable as a biological resource. The consequences of changes in biodiversity for people can stem both from a change in the diversity per se and a change in a particular component of biodiversity. Each of these aspects of biodiversity deserves its own attention from decision-makers and requires its own management goals and policies. There is also a diversity at multiple scales of biological organization (genes, populations, species, and ecosystems) which can be considered at different geographic scales (local, regional, global). For example, the introduction of weedy species to Africa will increase the species diversity of Africa while decreasing ecosystem diversity globally since the ecosystems in Africa become more similar in species composition to ecosystems elsewhere). This is why any single indicator, such as species diversity, is a poor indicator for aspects of biodiversity of concern for policy-makers.

The Millennium Ecosystem Assessment has recently assessed the state of the global ecosystems with respect to their ability to support people. It found that while biodiversity is critical for material welfare it also contributes to security, resiliency, social relations, health and freedom of choices. Yet, not all ecosystems and their biodiversity have to be “conserved”; many people have benefited over the last century from

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exploitation of ecosystems and their biodiversity, though at a growing costs due to degradation of many ecosystem services and exacerbation of poverty for other people. Changes in biodiversity were more rapid in the past 50 years than at any time in human history, mostly due to habitat change: biodiversity was lost through species extinction and also through reduced potential of components of diversity to provide a particular service.

Scenarios developed by the Millennium Assessment project that current rates of change in biodiversity will continue or accelerate with costs often higher than benefits. Trade-offs between achieving the 2015 targets of the Millennium Development Goals and the 2010 target of reducing the rate of biodiversity loss are likely, but there are potential synergies between internationally agreed targets relating to biodiversity, environmental sustainability, and development. Given the response times for political, socioeconomic, and ecological systems, longer-term goals and targets (such as for 2050) are needed to guide policy and actions.

Keywords: ecosystem services, human well-being, Millennium Ecosystem Assessment

Sustainable Management of the Montane Rainforests with Wild Coffee (*Coffea arabica*) at Bonga (SW Ethiopia)

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Originally, *Coffea arabica* L. (Rubiaceae) comes from the montane rainforests of Southwest Ethiopia where it is a natural component of the undergrowth. These rainforests, however, are already highly fragmented and are decreasing at a rapid rate because of their conversion into settlements and agricultural land.

Coffee is economically and culturally important to Ethiopia and one of the most treasured beverages worldwide. In the past, wild coffee was mainly traded on the local markets, but recently international companies have shown an increasing interest in coffee harvested from the wild. As the productivity of wild coffee is low, local people manage coffee forests to improve yields.

This study has the objective to assess how much wild coffee can actually be harvested from the forest and to evaluate the influence of wild coffee management on the floristic diversity and structure of the forest.

Vegetation surveys were conducted in four forest fragments in the vicinity of Bonga (SW Ethiopia). In the study plots, all woody (trees, shrubs, lianas) and herbaceous species (herbs, ferns, grasses) were identified and the forest structure was recorded. Before the harvest, the ripe cherries per coffee tree were counted to assess the coffee productivity. The coverage of the forest vegetation was estimated and the intensity of coffee and forest management was noted. The data were analysed statistically with multivariate methods.

Coffee forest management was found to have a positive impact on coffee yields. High management intensities, though, led to a disturbance of the natural forest structure, to a loss of typical forest species and to an increase in the abundance of ruderal and pioneer species. Selling wild coffee on the international market can increase farmers' incomes, but it is crucial to conform to production limits, which guarantee the protection of the floristic composition and the structure of the wild coffee forests.

Keywords: Coffee yield, forest biodiversity, forest structure, conservation

Understanding a Local Seed System: The Example of Sorghum in Southern Mali

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Sorghum (*Sorghum bicolor* (L.) Moench) is the staple crop in southern Mali. Besides providing grain for human consumption, the stover is used for animal feeding and for construction.

Strengths and weaknesses of the local seed system for sorghum were analysed as a base for the collaboration between plant breeders and farmers: choosing varieties that meet farmers' needs and strengthening the dissemination of improved varieties.

Over 400 households in two regions were interviewed in 2004 or early 2005 using a questionnaire for individual interviews about variety choice, seed management practices and information exchange. Key issues were clarified during a village level focus group discussion.

Sorghum shows a broad diversity in landraces. Between 5 and 14 different varieties exist per village and 2–3 different varieties are cultivated per family. Farmers grow different varieties to meet different needs such as diverse uses, adaptation to different types of soils, different maturity cycles and good storage traits.

The varieties are obtained for the first time by heritage in the family, by exchanges or gifts in the village and neighbour villages. Purchased seeds are of no importance. Locally the rare introduction of new varieties due to activities of research institutes and extension services can be observed.

Most farmers produce their own seeds every year: selection of panicles in the field before harvest, storage in form of sheaves attached in the granary, the house, the kitchen or in a tree.

Strengths of the system in terms of variety improvement are that farmers differentiate a large number of varieties, and regularly test new varieties. Also selecting panicles is an important skill.

Weaknesses of the system in the process of varietal change are the slow and geographically limited exchange of varieties, seeds and information. Dissemination is further limited because commercialisation of seeds by individuals is a taboo in the traditional society. The access to research generated varieties is still poor.

Keywords: Mali, plant breeding, seed management, seed system, sorghum, varieties

Assessing the Effectiveness of the Community-Based Seed Supply System for *in Situ* Conservation of Local Wheat Varieties

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Ethiopia is one of the countries with a high diversity in crop genetic resources. Between 1995 and 2003 the IBC/E (Institute of Biodiversity Conservation/Ethiopia) started to establish community-based seed banks at 12 locations in different agro-ecological zones. The main purpose being to enrich the diversity of locally cultivated crops and achieve an effective *in situ* conservation of endangered landraces. The objective of this study was, to document how gene banks presently respond to farmers' needs in order to approach a participatory and sustainable *in situ* conservation of plant genetic resources by the example of wheat. The Ethiopian durum wheat varieties, which contain numerous desirable traits for breeding, are particularly endangered due to lack of seed sources, market-oriented production, and competition with improved hexaploid wheat varieties. Farmers' motives to prefer certain varieties, to diversify their gene pools are determined by factors like original and current seed sources, consumption patterns, abundance and livestock type, access to land and seed, and risk aversion related to market uncertainty and difficult environmental conditions. In this study, four Ethiopian wheat production areas with different agro-ecological and socio-economic features were visited, in three of which seed banks existed. Per site 20–30 households, belonging to a Crop Conservation Association (CCA) or not, and cropping traditional wheat varieties or not were interviewed. Interviews covered their market situation and socio-economic conditions, as well as farmers' perceptions regarding properties of wheat varieties cultivated and production constraints in their environments. Additional data from group interviews and market surveys were used to reveal the distribution and/or gene flow of improved and traditional wheat and how they are influenced by the locally based seed supply system. At the seed bank sites of Gimbiču and Lome, seed supply of landraces is mainly through the seed banks, because farmers appreciate the lower transaction costs and interest rates for borrowed seeds. They practically do not consider other seed sources for landraces. Despite the formally equal access, seed banks do not entirely meet farmers' demand for highly appreciated landraces because social structure and interpersonal relations and/or information flow within the CCA play a dominant role for seed distribution.

Keywords: Agro-biodiversity, community, conservation, crop genetic resources, Ethiopia, gene flow, *in situ*, wheat

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The Legal Reality of Biodiversity Conservation in Indonesia

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As a policy biodiversity conservation takes on the form of legal interventions. These range from treaties in international law to statutes in national law; from the creation of administrative structures to spatial planning on the regional level to the implementation of protected areas. The latter alter the regulation of resource use on the local level rendering most activities within the designated area illegal.

While a programmatic shift from protectionist to community based strategies is on the way in international conservation organisations as well as national policies, there are scholars who already advocate a return to authoritarian approaches in order to address the current crisis in biodiversity conservation.

Against the backdrop of this debate this socio-legal comparative study investigates the legal environment of forest utilisation in four villages adjacent to Lore Lindu National Park in Central-Sulawesi, a biodiversity hotspot in Indonesia. This park was established in the early 80ies. Certain parts have been converted to farmland since the end of the 90ies, a period when the democratisation of Indonesia's political system that led to a loss of the authoritarian power of the state coincided with Sulawesi's cacao boom.

The main patterns of forest use and conversion as well as practices of protection are identified. Strong variations exist among the research sites and within the communities (e.g. between ethnic groups) regarding levels of encroachment. The claims to customary lands (*tanah adat*) within the park, and recent attempts of village institutions to control the exploitation of communities' forests and the area of the national park differ considerably.

Although the park is weakly protected, the declaration of a protected area alone with the possibility of sanctions has an impact on the individual's behaviour, in a socio-political system that is still perceived as erratic.

It is shown how the existence of a protected area, albeit weakly protected, shapes the social constructions of forest territories and resources.

Keywords: Biodiversity conservation, Indonesia, law, national park

Land Use Changes and Crop Management

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Dynamics and Heterogeneity in African Farming Systems: Strategic Niche Management? Or the (De)Fault of Poverty?

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Systematic analysis of smallholder farming systems across a wide range of agroecologies in Africa (see <http://www.AfricaNUANCES.nl>) reveals some intriguing patterns. Strong heterogeneity in soil fertility exists within very small farms. The breadth of organic C and N contents found across a whole region on a given soil type can be seen within a single farm across a distance of only 100 m! Such variation in crop productivity and soil fertility has been attributed to the intentional creation of heterogeneous conditions by farmers as a strategy for managing niches under risky rainfall environments. But an alternative explanation exists: that the commonly observed gradients in crop productivity and soil fertility are the inevitable result of resource scarcity. Recent evidence from studies in East and southern Africa will be presented that demonstrates the simultaneous degradation and conservation of soil fertility by farmers in different fields. Those listening will be invited to decide whether the human-induced heterogeneity in land quality described is the result of strategic niche management or the default of poverty.

Keywords: NUANCES, soil fertility

Vertical Nutrient Fluxes in a Traditional Mountain Oasis of Northern Oman

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Little is known about nutrient turnover in irrigated oasis agriculture as a criterion to assess their sustainability over time. Recent data on horizontal fluxes of nitrogen (N), phosphorus (P) and potassium (K) from a representative ancient mountain oasis in northern Oman indicated annual per hectare surpluses of 131 kg N, 37 kg P and 84 kg K. The fate of these surpluses remained, however, unclear. The purpose of this study therefore was to measure vertical nutrient fluxes (gaseous emissions of N₂O, NH₃ and CH₄ and leaching losses of N, P and K) in a farmer's field planted to alfalfa (*Medicago sativa* L.) across space and time. To this end a 12V battery-powered photo-acoustic multi-gas monitor (INNOVA 1312-5) was fitted to a custom-made Teflon-coated PVC cuvette of 0.30 m diameter and 10 l volume. The cuvette contained a battery-powered ventilator and allowed not only direct readings of the afore-mentioned gases in the field but also simultaneous records of the temperature and moisture of the air contained therein at an interval of up to 5 min. Detection limits for N₂O, NH₃ and CH₄ were 20 µg kg⁻¹, 200 µg kg⁻¹ and 400 µg kg⁻¹, respectively. Leaching losses below the major root zone of annual crops following irrigation events were determined with ceramic suction plates and cumulatively with custom-made resin cartridges of 0.11 m surface diameter.

Intensive measurements from spring 2005 with respective minimum and maximum air temperatures of 7 and 42°C yielded gaseous N emission rates equivalent to 2–24 kg N₂O, 1–104 kg NH₃-N and 3–1200 kg CH₄ per hectare and year. These values were strongly dependent on soil temperature and time after irrigation (soil moisture) but to an only smaller degree on the presence of manure compost. Leaching losses amounted to 2–6 % of the applied irrigation water whose nutrient concentrations allowed a first estimation of the range of such losses across the year. While further tests will certainly need to be conducted to assess the precision of these measurements, the results indicate the possibility to obtain real-time measurements of vertical nutrient losses from farmers' fields under difficult agro-environmental conditions with a high emission variability in time and space.

Keywords: Animal manure, gaseous N emissions, nutrient leaching, photo-acoustic gas monitor

Early-Season Termite Composition (Isoptera: Macrotermes) on Maize Fields on Two Soil Types in Two Agro-Ecological Zones of Zimbabwe

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Soil fauna plays an important role in tropical agroecosystems. Agricultural management techniques that involve the utilization of different crop residues such as conservation agriculture make use of this role to benefit crop production. A faunal characterization was carried out in the 2004/2005 cropping season at three sites in Zimbabwe. Henderson and Zimuto, sites have predominantly coarse grain textured sandy soils, (represent agroecological zones II and IV of Zimbabwe), whereas Shamva is on a red clay loamy soil (agroecological zone II). The aim of this study was to determine the species diversity and the density of termites as a key faunal group. Soil samples were collected from fields under conventional, reduced tillage treatments and adjacent natural woodlands. At Henderson Research Station and Zimuto, the fields had been left fallow for a minimum of three years. Termites were hand-sorted from excavated soil monoliths (25 x 25, 30 cm deep). *Macrotermes* was identified as the dominant termite species from all the three sites. There were significant differences ($p < 0.05$) in termite densities across the three sites in the order Shamva>Zimuto>Henderson. No immediately clear trend in vertical termite densities was found at the sites. Early in the cropping season, higher termite density was observed on the clay textured soils in agro-ecological zone II compared to the sandy soil site in the same zone and that in zone IV. Significantly lower termite densities were observed in natural woodlands.

Keywords: Conservation agriculture, direct seeding, termite diversity, termite density, natural woodlands, savannah

Food Quality and Livelihood

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When Two Cups of Tea are a bit Expensive — Assessing Technology and Development Strategies from a Farmers' Context Perspective

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The purpose of the paper is to address development strategies with respect to the interface between the global level, seen as international markets and agricultural research, and the local level, with a focus on marginal farmers. The absolute poverty which is the reality of marginal farmers forms a special challenge to development of technology and innovations which really are relevant and advantageous to the target group. Innovations and inputs that may appear economically feasible to the researcher may be prohibitively expensive to people living in absolute poverty.

The international agricultural research institutions have a strong tradition build on hierarchical thinking and expert domination. This tradition has been challenged and new, participatory approaches have become important and increasingly popular in research as well as in the development sector. However, the old expert paradigm is still alive, and many strategies are for instance still building on the assumption that farmers have interaction with extension officers as an end line of the research hierarchy, an assumption which often is misleading. Crop breeding programs, including bio-fortification efforts, are linked to a reductionist tradition which also may be at conflict with the complexities at local level, including multiple micronutrient disorders.

Successful research and development must build on contextual knowledge: take its departure the complexity of the local context, and the conditions generated by poverty. It will identify relevant constraints in plant growth conditions and resource entitlements of farming systems, access to inputs and markets, knowledge systems and routes of dissemination and spread of knowledge. This may include 'indigenous' technical knowledge and practices, but because the reality is under constant change also factors and institutions created by modernization: new soil constraints, new institutions, new knowledge pathways and communications. An escape from the linear extension model, and openness to new public/private partnership strategies is essential.

Keywords: Knowledge pathways, micronutrient, nutrition, strategies

Effects of Farmers' Perceptions on the Adoption of Modern Rice Varieties in Nepal

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Several modern varieties of rice have been released in Nepal to raise the productivity, a major staple crop. Farmers have adopted these varieties to varying degrees, especially in rainfed areas. This paper attempts to identify factors that affect the adoption of modern varieties of rice. Farmers considered suitability of rice varieties based on several characteristics. They were more concerned with biotic and abiotic stresses, which probably reflects the high incidence of these stresses in the rainfed condition. Modern varieties were superior over traditional varieties for many characteristics except in terms of taste. It is hypothesised that farmers' perceptions regarding varietal characteristics play a key role in explaining adoption behaviour. This hypothesis was tested using farm-level data from rainfed areas of Nepal. An econometric model that includes farmers' perception variables was found to be superior in explaining adoption behaviour than the ones that include only the usual farm and farmer related variables. Farmers' perceptions of the varietal characteristics such as pest resistance, drought tolerance and suitability for making special products were important in determining technology choices in the areas where current adoption rates are quite high. It was also found that the farms and farmers' specific variables such as education of the decision maker and his/her experience in rice farming, and availability of extension services have significant effect on adoption of modern varieties. Research approaches that incorporate farmers' preferences for various characteristics of rice in breeding programs and extension strategies that are geared towards providing accurate information for efficient revision of farmer perceptions are needed to raise the adoption rate.

Keywords: Adoption, factors, farmer, modern varieties, perceptions

Functional Food for the Poor — The Potential Impact of “Biofortification” on Public Health in India

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It is generally acknowledged that the Green Revolution has helped to prevent widespread famines, hunger and undernourishment. Yet, the Green Revolution mostly focused on solving the problem of protein-energy malnutrition and paid little attention to micronutrient malnutrition. Combating this hidden hunger, which affects and threatens billions of lives worldwide and which economic development and income growth alone are not expected to remedy any time soon, was left to non-agricultural interventions like supplementation and industrial fortification. Only more recently did the role of agriculture in addressing this aspect of food and nutrition security come to the fore: biofortified staple crops — i.e. food crops that are being bred for higher levels of micronutrients like iron, zinc or provitamin A — have the potential to improve public health in micronutrient-deficient populations. Yet, knowledge about the cost-effectiveness of biofortification is limited. This study analyses the expected costs and benefits of (i) iron-rich and (ii) zinc-rich staple crops in India, which are currently being developed in the framework of the HarvestPlus Challenge Programme of the CGIAR.

For the analyses health economics models that build on the disability-adjusted life years (DALYs) approach have been developed; DALYs can be used to measure health as they incorporate mortality and (weighted) morbidity data in one single index. Health improvements due to improved nutrition can therefore be expressed in the number of healthy life years that are saved through an intervention; current and expected nutrition statuses are derived from nationally representative food consumption data. Given that both crops are not yet cultivated, these models are used for ex-ante studies. It is hypothesised that the continuous streams of health benefits resulting from a single investment in the development of biofortified crops will prove to be cost-effective. Preliminary results indicate that saving one DALY through iron biofortification costs between US\$ 0.36 and 1.78. For zinc biofortification these costs range from US\$ 1.80 to 8.90. Both sets of results would prove a high cost-effectiveness by World Bank and WHO standards and yield internal rates of return of 74–152 % and 46–92 %, respectively. These findings suggest that biofortification can be a worthwhile public investment.

Keywords: Biofortification, cost-benefit analysis, cost-effectiveness, DALYs, health benefits, India, iron deficiency, iron-rich and zinc-rich staple crops, micronutrient malnutrition, micronutrients, plant breeding, rice, wheat, zinc deficiency

The Importance of the Wild Coffee Resource for Generation of Monetary Income for Farmers in South-West Ethiopia

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This study investigates the importance of wild coffee as a resource for generating monetary income for local farmers in the South-Western region of Ethiopia, the Kaffa Zone. It is the origin and centre of the genetic diversity of textitCoffea arabica. The COCE project aims at generating an insight into the overall ecologic and socio-economic aspects of the wild coffee and its use, to assist in developing conservation plans to save the forest, the coffee's habitat, and the valuable coffee-genetic diversity for future breeding programmes. In respect of the concept of sustainable development, it is important to consider not only conservation but also socio-economic goals of the affected people. An important aspect in this context is the dependency of local, mainly subsistence farmers, on the use of coffee and other Non-Wood-Forest-Products (NWFP) to generate monetary income for future development. The livelihood (with a focus on the activity and income portfolio) of farmers and its diversification strategies are used to measure the farmers' dependency and focus on coffee production. The basic hypothesis of the work is, that farmers are highly dependent on coffee. It is assumed that besides the fulfilment of subsistence demand for household survival the second focus is put on coffee production to generate monetary income for economic development. The study is an empirical case study undertaken in South-West Ethiopia Research data was collected using a semi-structured questionnaire. Interviews were realized with 32 farmers, all participating in coffee production. The analysis used descriptive statistics and key word analysis for qualitative data. Results are discussed with reference to the currently ongoing discussion amongst scientist and practitioners about the role of NWFP as a viable source of monetary income and contribution to conservation goals. The results account for the importance of NWFP use in the livelihood diversification process. The results show that farmers are highly dependent on coffee production to generate monetary income. Involvement in non-farm work as alternative source for monetary income generation is very low and limited. Low paid agricultural labour work is only carried out if no other option emerges. Farmers endue over a diverse activity portfolio, but mainly consistent of subsistence oriented activities. As farmers use surplus from those primarily subsistence oriented activities as a source of income it is misleading to speak of the prevalence of a high income diversity. Farmers don't create a diverse income portfolio including off- and non-farm activities due to locational and cultural specifics and limited options. All aspects of development are connected to the income achieved through coffee production. If conservation measures will be carried out this will reduce the farmers' forest access and thus coffee resource use. As to fulfil the conservation goals, the consideration of the income importance of coffee is an essential aspect.

Keywords: Ethiopia, livelihood diversification, non wood forest products, peasants economics, wild coffee

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Improving the Protein Content in Staple Crops via Biofortification

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In many poor developing countries, in which consumers rely only or mostly on low-protein staple crops for food, daily intake of essential amino acids (EAAs) is usually not sufficient because other high-protein sources such as meat, fish, or soybean are not readily available. In order to alleviate malnutrition in these countries, EAA intake could be improved by protein biofortification of these staple crops. Cassava for instance is one of the most important food crops in tropical countries. More than 600 Million people rely on it, primarily as a subsistence crop. Together with rice, these two crops serve as main source of carbohydrates for more than half of the world population. The greatest nutritional value of cassava lies in the starchy storage root, which contains high levels of carbohydrates but only a small amount of protein. Similarly, polished rice is an important source of carbohydrate, but it is low in protein because most proteins are found in the seed coat and aleurone layer, both of which are typically discarded during polishing of the rice seed.

Suitable protein candidates for biofortification of cassava and rice include the natural storage protein SporaminA from sweet potato as well as an artificial storage protein (ASP1) designed for optimal human needs in terms of EAAs. ASP1 has been transferred and expressed in cassava and rice successfully, but protein accumulation was variable and usually low. Cellular targeting is considered as a possible solution to overcome limited protein accumulation. We have successfully targeted a green fluorescent protein (GFP) to different cellular organelles in transient assays in cassava protoplasts and GFP:ASP1 fusion assays will reveal detailed information about suitable protein storage locations.

In the long term, we hope that these studies will lead to increased protein levels in two of the world's most important food resources, and so we could provide people lacking EAAs with value-added cultivars of cassava and rice.

Keywords: Biofortification, cassava, essential amino acids, rice

Liberal Markets versus Market Protection

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Chain Development in the Context of Market Liberalisation: Possibilities to Upgrade Pro-Poor Agrichains under Conditions of Increased Competition

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The emergence of chain coordination in agriculture and food production can be seen both as a consequence and a catalyst of market liberalization. Market liberalization constitutes a policy to purposefully change the conditions under which local producers, processors and marketers in developing countries can participate in global commodity chains. There is evidence that the configuration and dynamics of global commodity chains, a result of the structures and power relationships on international markets, have restricted the opportunities for resource-poor farmers and small-scale processors in developing countries; the main share of value added in global commodity chains falls into the hands of internationally operating traders and retailers in the developed world. In a given context of market liberalization governments and donors have fostered policies to “upgrade” local commodity chains, that is, enabling chain actors to improve products and processes in a way that increases their revenues and contributes to a better integration of the chain. However, to date, those efforts were only successful in some niche products (e.g. off-seasonal fruits and vegetables, organic food) and some few commodities (soy, wheat, cotton). In some cases (e.g. pineapple, ornamental plants) the involvement in global commodity chains has brought relevant knowledge and technology to the local agents in developing countries. In most cases, however, chain agents in developing countries haven’t applied the knowledge and technologies leading to product and process improvement. This knowledge and technology, however, is often at hand; what is lacking is the capability among the economic agents in disadvantaged farming communities to absorb it. Therefore two types of interventions shall accompany any market liberalization policies, especially if those touch low value commodities and subsistence crops: first, developing product and product improvement measures that are useful and applicable in small-scale resource-poor farming environments, and second, capacity building on a broader scale to enable chain actors in developing countries to absorb knowledge and technology.

Keywords: Value chains, upgrading, innovation, Central America

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Projecting Benin's Food Gap for 2025

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According to the Human Development Index of the World Health Organisation, Benin is one of the least developed countries in the world with an annual population growth of about 3 percent. Although malnutrition occurs especially in children, the food supply situation seems more or less satisfying at the moment. But how will the situation develop in the next 20 years if population growth remains unchanged, and agricultural productivity remains at its current low levels? Demand in 2025 will most likely be met exclusively through the extension of cropping areas, thus increasing tensions between farmers and livestock herdsman which depend on natural pasture and fallow land. It is well possible that an over-use of land resources will increase the need for food imports. With the assistance of BenImpact, an agricultural sector model for Benin, this question is analysed quantitatively. BenImpact is designed as a regionalised farm-household model for the whole of Benin, where income and agricultural prices are endogenous and trade between different departments within the country, neighbouring countries, and the world market is possible. The model is split into a demand and a supply module which are solved in iterative steps. In the supply part, regional prices are computed as the marginal cost of production at the production levels that would clear all markets with given demand quantities. Those regional prices and income are in turn used to compute regional demand quantities. Demand and supply are solved iteratively with the objective to maximise profits and minimise transport costs subject to land area restrictions, processing capacities and the availability of labour. The agricultural year is divided into four periods to illustrate seasonal changes and to ensure that food requirements can be satisfied throughout the year. Introducing a shock, here a significant rise in population as population is an exogenous variable, the results are compared in a comparative-static way with both the base year situation and the millennium development goals.

Keywords: Agricultural sector model, BenImpact, Benin, food security

Volatility and Integration of Rice Markets in Java, Indonesia: A Comparative Analysis before and after Trade Liberalisation

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Indonesia's rice economy is in a transition from being a sector heavily regulated by a state trading enterprise (BULOG) to being market-oriented. Before September 1998, BULOG defended a floor price and a ceiling price for rice through a combination of the following policy instruments: domestic procurement to lift paddy prices, market operation to defend ceiling rice retail prices, and import monopoly. To support its operation, BULOG was equipped with financial support from the Indonesian Central Bank. Since September 1998, BULOG's import monopoly was removed.

Trade liberalisation is expected to bring about a better functioning of markets. Two essential measures of market performance are price volatility and market integration. While higher stability of prices would protect rice producers from fluctuating farm income, higher market integration is necessary for efficient resource allocation. Therefore, this paper particularly addresses the following research questions: (1) How volatile were paddy and rice prices in the pre- and post-liberalisation period? (2) Did integration of domestic rice markets improve after trade liberalisation? While standard deviation of inter-year price growth is used to address the first question, the second question is addressed via multivariate and bivariate price transmission analysis using the Johansen maximum likelihood method.

Using monthly producer price series from 1987 to 2002 and monthly retail price series from 1981 to 2004, the results show that the volatility of both producer and retail prices are higher in the post-liberalisation period. Before trade liberalisation, markets are integrated. In the post-liberalisation period, 2 co-integrating vectors among 5 markets on Java — which should be 4 if markets are integrated — are found with multivariate co-integration. The ensuing test for bivariate co-integration finds that 60 percent of market pairs are co-integrated. Full integration is not found, which may be due to the delayed adjustment of markets to the new policy.

Keywords: Indonesia, market integration, price volatility, rice

Global Rice Trade: Dynamics, Policy Conflicts and Strategies in Africa

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Globally, about 6 % of the total rice produced enters the international market, indicating that most rice is consumed in the producing countries. The rice export market is thin and concentrated, with Thailand, Viet Nam, India, China, Pakistan, the USA, Australia, Italy, Uruguay, Argentina, and Spain as major exporters. The nature of the international rice market provides a platform for highly variable prices, which are largely influenced by policy and weather conditions. Global rice trade policies are becoming increasingly liberalised following the WTO, EU and World Bank trade agreements. These changing policies have direct impact on rice production, consumption and trade in African countries.

The international rice trade policies can be characterised by importing and exporting countries. While importing countries pursue market-stabilising policies, exporting countries pursue policies to promote rice exports. Strategies like subsidies, credit guarantees and state-controlled trading monopolies, bans or quotas on rice imports, etc. are among policy strategies implemented to isolate their domestic markets from external competition and to boost exports.

African countries, particularly those in SSA are net rice importers spending close to 1.4 billion US dollars annually on rice imports, accounting for 19 % of the continent's total grain import bill. Given this increasing rice consumption trend in Africa, rice self sufficiency objectives continue to be pursued as a means to achieve food security. In the major rice consuming countries, rice is a staple and perceived as a 'political crop'. Therefore, governments are sensitive about price effects on producers and consumers. Thus, governments intervene to protect producer and consumers from large price fluctuations.

WARDA and its partners are using science to develop technologies and knowledge for application along the rice production to market chain. Among the most recent successes, is the release of the 'New Rice for Africa' (NERICA). This paper analyses the global rice trade dynamics and policies; and draws lessons for promoting rice production and marketing in Africa. It also highlights the programs and strategies that are promoting NERICA and estimates expected impact, the challenges and new opportunities for achieving rice self sufficiency in Africa.

Keywords: Africa, marketing, NERICA, policy, rice trade

Agricultural Import Surges in Developing Countries: How Do They Arise?

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An import surge is considered a situation in which the quantity or value of imports suddenly exceeds a 'normal' level. Such a sudden increase in agricultural imports is widely considered to result from developed countries' agricultural policies and to be a problem for food security in developing countries because imports would replace domestic production. This, however, may not always hold: in the case of drastically reduced domestic supply, e.g. for climatic reasons, import surges may contribute significantly to food security and may be a proof of the well functioning of the integration of the national markets in an international environment. On the other hand, an import surge resulting from a transitory exogenous factor may result in low domestic prices and drive local suppliers out of the market. This, in turn, may affect food security negatively at a later stage.

This paper starts with a discussion of how import surges should be defined precisely. Subsequently, factors which can contribute to the genesis of import surges are systematically reviewed and analysed quantitatively. Some of these factors clearly stem from the importing country. These are for example domestic supply instability because of climatic or political reasons, unilateral changes in trade policies, or changes in the exchange rate policy of the importing country. Others clearly stem from third countries, for example changes in agricultural policies or supply volatility for any other reasons. For some factors, the mapping to domestic or exogenous origin is not unequivocal: an importing country may change its domestic trade regime due to external reasons such as the implementation of trade liberalisation agreed upon in the WTO, the implementation of Structural Adjustment Programs (SAP), or the membership in a Regional Trade Agreement (RTA).

Based on a statistic analysis of trade data it is shown in the conclusions that it is mainly the domestic factors which dominate the emergence of import surges. In many cases import surges may therefore contribute to food security rather than being an obstacle.

Keywords: Food security, import surge, trade policy

Increasing Resilience through more Effective Livelihood Capital Assets

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On Rational Solidarity: Theory and Evidence from Rural Producer Organizations in West Africa

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Rural producer organizations (RPOs) are a pervasive feature of village life in Francophone West Africa, and are an important component of household survival strategies. We use a theoretical model based on the secession literature (Bolton, 1997) to contrast “dictatorial” versus “democratic” views of RPO functioning. The theoretical hypotheses are then tested on a rich Senegalese dataset using rainfall data as excluded instruments. We pay particular attention to the “weak instruments” problem highlighted in the recent econometrics literature through the use of diagnostics suggested in Stock (2002), the new specification tests proposed by Hahn (2002), and the instrument selection criteria proposed by Donald and Newey (2001). Our preliminary results come down squarely in favor of the “democratic” view of RPO governance.

Keywords: Senegal, rural producer organisations, econometrics

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The Interlinks Between Agricultural Export Diversification, Food Security and Livelihood of Farm Households in Southern Ghana

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Policy makers in developing countries have been concerned with the economic and political risks associated with heavy dependence on specialised raw materials as main sources of government revenue and foreign exchange. Development partners and donor agencies have equally extolled the need for these countries to diversify their export base as a poverty alleviation strategy. To this end, several African countries have tended to focus on non-traditional exports which reflect their comparative advantage and for many countries the export of non-traditional horticultural crops has been favoured. In Ghana, crops such as pineapples, mangoes and papaya appear promising because of their high labour intensity and the expanding demand for fruits in industrialised nations. However, the appropriate strategy for achieving pro-poor growth in most countries is still a subject of intense debate. Consequently, few studies have examined the linkage between export diversification and microeconomic performance.

The study focuses on a household survey undertaken in the forest and coastal savannah transition zones of Ghana, where the farming system has undergone a remarkable transition from an established system of food crop farming for sale to urban consumers to an intensive production of horticultural products for export to European consumers. Probit and Logit regression models were used to estimate the determinants of participation and food availability while a linear function was used to compare the incomes of households producing only horticultural export crops with those producing only food crops vis-à-vis those indulged in the combined scenario.

Whereas the contribution of diversified exports to macro-economic growth cannot be disputed, evidence from our study indicates that the micro level distributional effects has not favoured some groups. Results show that households involved in export horticulture are better off than those which are not. An assessment of the determinants of participation in the sector however suggests that, some households may face important constraints to participation in the sector. The paper concludes that non-traditional exports as a source of livelihood among smallholder farmers depends on several factors including access to local institutional services, technological know-how, policy environment, trends in international markets and most importantly, their interplay with livelihood adopting strategies.

Keywords: Export diversification, food security, Ghana, household livelihood, non-traditional exports

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The Women Labour Allocation Dilemma in Organic Cotton Production in Benin: Using a Nonlinear Programming Model for Decision Making

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Similarly to most francophone West African countries, the economy of Benin is highly dependent on cotton production. Cotton provides more than 64 % of the export income and 24 % of the Gross National Product. At micro level, it generates 36 to 41 % of household's income.

The adoption of organic cotton farming by households affects significantly the size of women's cotton farms. In Central Benin, a typical household has a common farm, which is managed by the husband. The latter provides his wife with a small plot to grow crops of her choice. However, she is required to work prior on the common farm. Cotton farming improves women's financial independence and women are intended to increase the size of their cotton farm. This trend is subsequent to the adoption of organic farming and constitutes a potential dilemma in the household upon the wife's labour allocation between her own farm and the common one. The present study shows a model that can guide a concerted resources allocation within a household in Central Benin.

As methodology, a nonlinear programming was used to maximise the household farming income under the constraints of land and labour availability. Two scenarios were analyzed: a) increasing women labour demand in the common farm, and b) increasing land demand by women for their own farm.

The first scenario shows that the optimum household income requires an increase by 20 % of wife's labour in the common farm. However, the corresponding income distribution deepens on the gender gap. According to the second scenario, the optimum household income is reached by increasing the share of land used by women from 20 to 40 %. This reallocation reduces the gender gap in income distribution. This scenario is achievable only if, in short term, adequate credit facilities are given to women to hire labour and in long term, relevant policy measures are initiated to ease access to land by women. The model indicates also that, to obtain a consensus within household, the wife should allocate at least one third of her labour to the common farm and she should use less than half of total household's land.

Keywords: Benin, household income, organic cotton, women labour

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Credit Rationing of Farm Households and Agricultural Production: Empirical Evidence in the Rural Areas of Central Sulawesi Province, Indonesia

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The agricultural sector provides the highest contribution to economic development in the Central Sulawesi Province, Indonesia. On average, the share of the agriculture in the Gross Regional Domestic Product (GRDP) is more than 40 % (2003). However, poverty is a widespread problem found in this area, as indicated by almost 46 % of the total households are categorised as poor and most of them are farmers. Smallholders and poor farmers may perpetually be trapped in poverty due to lack of finance needed to undertake productive investment. This is indicated by lower rate of advance agricultural technology adoption, which results the productivity of some agricultural products in this area are lower compared to the national average.

This paper addresses the question of whether greater access to financial services increase agricultural production. Specific research questions addressed are as follow: **(1)** How many households have access to formal credit markets? **(2)** How many households are credit constrained? **(3)** What factors influence that households are credit constrained? **(4)** How does credit rationing influences agricultural production?

As many studies have shown, many rural households lack access to either formal or informal credit institutions. In the rural areas of Central Sulawesi Province, particularly in the vicinity of the Lore Lindu National Park only 21.5 % of the households have access to formal credits. The results also show that under certain conditions, only 18.1 % of the households are not credit constrained. Most households are credit constrained due to a lack of collateral and because of the self-selection problem.

The econometric analysis consists of two parts. The first part explores the determinants for a household to be credit constrained, focusing on the formal credit market by using a Probit model. In the second part of the analysis, we investigate the influence of being credit constrained on the rice production by applying a switching regression model. The results of the Probit model show that human capital (i.e. education and age of the head of household) as well as wealth and risk-bearing indicators are significant in determining whether a household is credit constrained.

Keywords: Agricultural production, credit rationing, econometrica, Indonesia

Trade-Offs Between Smallholder Welfare and Environmental Services in the Eastern Brazilian Amazon: Technology and Policy Options

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For more than a century, smallholders in the Zona Bragantina (Northeast of Pará, Brazil) have depended on fallows as a natural nutrient source for annual food and cash crop production in a slash-and-burn system. Productivity losses due to recent negative soil nutrient balances are a problem faced by many farmers in the region who have developed various strategies for dealing with it. One prominent example is the adoption of mechanical land preparation technologies combined with the use of chemical fertilisers. This paper examines two types of mechanical land preparation, i.e. ploughing and mulching, that are currently being tested in the study area.

The paper first presents and discusses the baseline results of the farm-level linear and non-linear bio-economic models developed to simulate smallholder land use, product mix and technology choice decisions under market and production risk. The models are then used to examine the effects of the introduction of ploughing and mulching. Results suggest that the use of mechanical ploughing is affordable and would likely improve farm-household income, while leading to large losses in below- and above-ground carbon and to an increase in temporarily unproductive fallow land. The introduction of mechanical mulching of above-ground biomass, on the other hand, will likely positively influence carbon sequestration and fallow conservation, but is unaffordable to smallholders at its current costs. Policy instruments, such as a tax on land that is slashed and burned or payments for environmental services such as carbon sequestered appear to be feasible options to maintain natural resource quality without halting technological change and the economic benefits it brings to smallholders. Estimates of the levels of taxation and payments for environmental services required to facilitate the adoption of these technologies by smallholders are provided.

The final discussion centres on how research results could guide existing policy dialog and implementation in the area.

Keywords: Alternatives to slash-and-burn, bio-economic model, carbon, fallow system, risk analysis, technology adoption

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Vulnerability or Resilience? Development in a Network Perspective

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In contrast to actor oriented approaches, a network perspective of development focuses on interdependencies and relations into which persons, organisations or social units like communities etc. are integrated. Not individual capacities and competences (or lack of these) defines vulnerability or resilience, but relations and interdependencies determine agency. From recent research on reconstruction following disasters, it can be shown that vulnerability results from either reduction of interdependencies that lead towards entropy or a too rapid increase of interdependencies resulting in over-complexity, i.e. integration into contradictory unstructured interdependencies. Most development projects increase interdependencies and therefore bear the danger to generate over-complexities leading towards disasters for individuals, households, communities or even beyond this. (see in this context the discussion of “development - displacement - dispossession”). In contrast resilience can be defined as structuration of interdependencies through institutions. Thereby complexity remains, i.e entropy is avoided as well as over-complexity because interdependencies are structured. Accordingly, development should focus on resilience rather than vulnerability. This requires a new point of view though: Vulnerability looks at deficits especially of individuals or semi-individuals like households. In contrast, resilience refers to strength of social units to cope with challenges, including the challenges brought about by development projects.

Three examples will be presented to explicate these arguments:

1. Reconstruction in Pang Nga province, Thailand after the Tsunami: Not the big international organisations solve problems but the reconstruction is based on local initiatives.
2. Initiative or expectation: Comparing responses of the Lahu and Lisu minorities to a large scale development project in Northern Thailand.
3. Responding to urban challenges: Communal self-organisation in a Bangkok slum area.

Keywords: Vulnerability, Resilience, Development Projects

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Make Natural Resources Last by Changing Women's Access to Assets - Experiences from Northern Viet Nam

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Poverty is not equally distributed among men and women as 70 % of the poorest people in the world are women and children. This is also true for Viet Nam, where women have little control over their life, assets, and income. Moreover, their social positions are normally inferior to those of men. Poor people face many risks and have thus developed over time sophisticated livelihood strategies. They are often based on their asset and resource endowment. As natural resources are limited, they need to be utilised efficiently and sustainably.

In 2004, gender sensitive field research was conducted with approximately 80 rural men and women of different ethnic groups in two provinces of Northern Viet Nam. Qualitative research, which relied on Participatory Rural Appraisal tools investigated gender-specific roles and entitlements. This included labour division, power structures, possession of assets, decision-making processes and risk management strategies. The Sustainable Livelihood Approach of the Department for International Development, UK, served as an analytical framework to identify the available assets as well as assess internal and external factors that affect the socio-economic situation of the rural poor. Own findings were supplemented by observations from micro credit projects in the region, which encouraged women to participate in an agricultural training and to obtain credit.

It was found, that all assets, including natural resources, are considered to be owned by men, they also have the primary right to decide upon their use. Yet, the risk-management strategies hardly vary between women and men. In case of a crisis, it is the household as a whole which makes use of the available resources and the existing social network, not individual household members. Nevertheless, if the access of women to certain assets (e.g. knowledge and credit) is increased, their social position improves and thus leads to more involvement in the decision making process of the household. In the long run, the changed composition of assets has the potential to improve women's capabilities to use the scarce natural resources. This leads to a higher efficiency in the household's resource use and hence reduces its vulnerability.

Keywords: Gender, livelihood strategies, resources, Viet Nam

Women's Empowerment: Does the Increase in Gender Equity Upsurge Household Food Security in Subsistence Farming?

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Despite substantial efforts from public and private institutions supported by bilateral and multilateral donors, food insecurity still prevails as a major challenge for millions of Nepalese. Its effect seems to be more chronic with women because of deep-rooted unequal distribution practice in traditional rural communities. Like other Asian and African countries, women's overall socio-economic status is lower than its male counterpart. The low Human Development Index (0.48) has a great spatial variation and the Gender Development Index (0.46) is further exacerbated. This prevailing situation inspired to excavate the hidden myths of women's empowerment in outskirts.

With versus without project evaluation approach was applied as a research methodology to analyse the contribution of project intervention to curtailing the gender differentiation in technology transfer, sharing resources, and labour allocation to farm household activities. A field survey was conducted to collect primary data applying multi-stage probability random sampling technique for 120 respondents and purposive sampling for 45 key informants. The generated cross-sectional data was analysed using descriptive statistics, econometric model and qualitative techniques.

The econometric analysis on institutional sustainability reveals an inverse relationship with men's chairmanship and functional status of farmer's group. Similarly, score ranking of institutional performance of different types of groups also reveal similar findings. Besides, women's access to technology transfer enumerated by the Lorenz curve and GINI coefficients ascribed the positive relationship of project intervention to women's empowerment. Women's opportunities to participate in capacity building, natural resources management and social activities have been attributed to fewer hours involvement in household, whereas higher hours in farm activities is found to be significantly different ($p < 0.001$) between the groups. The reduced margin of wages differentiation between male and female labour has illuminated the economic potentiality of women to boom farms' physical productivity.

The challenge of securing enough food at household level is easily obtainable if women's labour gets streamlined in production process. Access to resources, most importantly capacity building should be approachable to both types to enhance their level of efficiency thereby to maximise farm productivity. Furthermore, the positive contribution of women to household economy stipulates the necessity of liberalising gender equity policies.

Keywords: Farm households, food security, project intervention, women empowerment

Social Networks as Means of Information Exchange and Risk-management — A Case Study from Northern Viet Nam

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Poor and vulnerable households in Viet Nam and elsewhere have a fragile and very finely balanced livelihood system. Shocks and crises can destabilise the households for many years and severely affect the welfare and livelihood strategies of the household members. This can easily lead to an overexploitation of natural resources. In developing countries, public safety nets often are incomplete or non-existing. Financial and extension services are lacking and hence, rural households tend to be left behind the socio-economic development of a country. Therefore, they have to find their own ways of managing production and livelihood risks, using their natural, physical, human, social and financial assets. One risk-managing strategy is the formation, maintenance and use of social networks. These social networks can serve as informal risk-sharing arrangements, but also as sources of information for an improved agricultural production and marketing base.

In Northern Viet Nam, three households of two ethnic minorities were selected to investigate the relationships between network members as well as the use of their extended social networks (networks comprised between 12 and 32 households) in order to cope with a crisis. Information was obtained through the use of a semi-structured, gender-sensitive questionnaire as well as several Participatory Rural Appraisal tools. Quantitative network data were analysed using the software UCINET.

Kinship turned out to be the major factor for network formation but also the level of wealth is an influencing factor for the formation and size of networks. As self-interest is the main motivation for helping each other, mutuality is of utmost significance and when not guaranteed or anticipated, support is very limited. Obviously, the network capacities of poor people are much earlier reached than those of richer people. Therefore, social networks are able to provide basic support, but are insufficient to entirely buffer a crisis of a poor or vulnerable household. Here other safety mechanisms are needed. Nevertheless, as the social networks also serve to exchange information, e.g. on sustainable agricultural methods, marketing possibilities and likewise, they may contribute to reduce food insecurity.

Keywords: Viet Nam, social networks

Socio-Economics and Food Security of Farming Families in South East Nigeria

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Farming families in Nigeria have to cope with food supply shortages, price fluctuation and pressure to get 'more' out of thinned out resources especially land. Some of the reasons for this situation include poverty, near absence or inadequate infrastructure, population explosion and unstable macro-economic environment. The south east Nigeria is generally densely populated with an average of 480 people per square kilometre. However, there exist in some areas an imbalance of the population distribution even within the same locality which has implications for resource availability and capacity.

This study examines families' ownership and access to resources such as land, labour and capital; the impact to these on family living standard and household food security (supply and access). To achieve this, the Farming systems approach is used. The farm-family-household system is considered as a whole which ensures that the overlaps between the sub units are considered. 105 randomly selected families were interviewed. These were eventually clustered into two main groups, the Resource Rich and the Resource Poor. Descriptive, comparative and econometric analyses were carried out.

Result show that income of the two groups differ significantly, in both cases off farm income plays an important role. The farming systems in highly populated areas have relatively smaller resources and capacity base, are crop oriented and have a lower living standard. They sell more of their outputs but purchase less to meet household food supply. The farming systems located in low/medium populated areas expend more on market supply purchases though they have more land resources. Both groups show desires for more food in terms of increased meals per day, quantity of food eaten; and a need for better quality. There is clear indication that access to food either through own supply or market purchase is not a guarantee of food security for both groups.

Keywords: Families' resources (ownership, access and use), food security, living standard

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Tenure and Economic Valuation of Natural Resources

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Economic Valuation of Environmental Benefits in Developing and Emerging Countries: Theoretical Considerations and Practical Evidence from Thailand and the Philippines

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The contingent valuation method (CVM) for the assessment of the social value of environmental benefits accruing from public projects has gained increasing popularity in developing and emerging countries. However, it must be scrutinized into the transferability of this method from the socio-economic context of industrialized countries in which it was originally applied to developing and emerging countries. This paper gives a brief introduction and an overview of the theory of economic valuation of environmental project benefits and highlights a number of problematic issues that arise in the context of the application of the CVM as one popular valuation method in the context of developing and emerging countries. The theoretical considerations are exemplified by two practical valuation studies conducted in Northern Thailand as a representative of an emerging country context and in a rural area of the Philippines as a representative of a developing socioeconomic context.

In Northern Thailand a CVM study values the benefits from an improvement of suburban tap water supply that is currently negatively affected by farming activities in the uplands. The achievement of drinkable water quality requires a substantial reduction of the use of pesticides which implies further benefits for the environment and the surrounding ecosystems. Using participatory valuation methods we aim at an improvement of the validity of CVM mail surveys which prove to be much less costly than the traditional personal interviews. In the rural areas of the Philippines a comparative CVM study provides insights with respect to the different response behavior to questions in a CVM interview in two distinct but representative socioeconomic contexts. The study finds very impressive examples for possible pitfalls in the interpretation of CVM results in rural areas of developing countries. In largely subsistence based communities the numbers seem to tell a different story than in more developed regions. These concerns need to be taken into account when interpreting CVM results and deriving policy implications for environmental projects.

In summary, the practical evidence presented in this paper leads to a number of suggestions of how to improve the application of this method in order to obtain more valid results for public policy.

Keywords: Contingent valuation, drinking water supply, participatory valuation techniques

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The Big Five Factor Model in the Context of Resource Valuation: A Case Study in Mae Rim, Chiang Mai, Northern Thailand

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Despite its ongoing debate, the Big Five Factor model has been acknowledged as a step forward in the personality trait theory. It has been developed to represent any individual's personality within the five aggregate domains which are Neuroticism, Extraversion, Openness to experience, Agreeableness, and Conscientiousness. Though, it has been validated across various countries, cultures, ages, and gender its utilisation has mostly been restricted to the context of people's job performance and psychotherapy. However, it is reasonable to assume that personality traits have also an important role in environmental resource valuation methods. The aim of this paper therefore is to integrate the Big Five Factor model into the resource valuation study. Based on the Theory of Reasoned Action (AJZEN and FISHBEIN, 1975), this study tries to explain environmental behaviour of people as expressed by their stated Willingness to Pay (WTP) by using their own personality trait. To this end, a study applying Contingent Valuation Method (CVM) was carried out to elicit people's WTP toward an improved tap water supply in Mae Rim district, Chiang Mai province, Thailand. Respondents' personality traits were investigated using the NEO-FFI test. Data were collected during December, 2004 in Mae Rim using both face-to-face and mail survey. The results show that some character traits of respondents in fact have an effect on their stated WTP. Different hypotheses behind these findings are discussed. The most important implication that can be derived from this study is the possibility to establish personality traits into internal test of response plausibility, which is important since CVMs are entirely hypothetical.

Keywords: Personality trait, resource valuation, Big Five Factor

Towards Economic Efficiency While Sustaining Rural Livelihoods: Socio-Political Dynamics and Resource Use Strategies in Rural Namibia

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Pressures from globalisation compel many developing countries towards modifying their economic policies in an attempt to enhance their international competitiveness through efficiency in key areas. In the process, the required complementary social, environmental and institutional reforms which generate sustainable and equitable improvements in human conditions are often neglected, thereby boosting the prevailing poverty-environmental degradation relationship. Although a post-apartheid Namibia has come a long way with attempts at correcting past injustices towards the rural poor, very little is known about the real impact of these policy changes on the target groups.

Comparative quantitative studies concentrating on policy effects on sustainable resource use and livelihoods were therefore carried out in selected resource-dependent communities in the north-eastern and southern regions of Namibia, within the framework of the BIOTA Southern-Africa research project. This paper analyses the possible impacts of market-based policy instruments, such as water fees and land registration, on rural livelihood- and food security strategies.

Results show that shifting from a “no fee” to a “minimal fee” situation has immediate effects on the household income and consequent expenditure decisions. A balance between paying for water consumption or school fees needs to be drawn by many households. While the current lack of sanctioning structures for non-compliance to policy stipulations makes the choice seemingly obvious, still some households have indicated that sacrifices on education for their children have been made. The paper secondly analyses how institutional incapacity in land registration processes negatively affects the implementation of policy structures on regional and local levels, thereby impeding the intended efficiency in resource conservation and livelihood assurance. Lengthy bureaucratic processes and high transaction costs for the resource user serve as disincentives for policy adherence, while local organisational structures, on the other hand, have unclear procedures and responsibilities along with distrust, hindering their effecting of the rules.

In conclusion, policy making in Namibia currently mirrors the growing dilemma of balancing the environment, livelihoods and economic efficiency experienced by the majority of developing countries.

Keywords: Globalisation, institutional change, livelihoods, Namibia, policy instruments

Payments for Environmental Services in Costa Rica: A Forest Site Selection Tool Based on Spatial Diversity of Environmental Service Provision, Risk and Opportunity Costs

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The payment for environmental services (PES) is a widely acknowledged and increasingly popular market-based financial instrument for the conservation of natural forest resources. The payment acknowledges the services forests provide to society (e.g. water regulation, carbon sequestration and biodiversity protection) and thus their crucial role at the very beginning of the food chain, e.g. for the provision of irrigation water. The payment helps to internalise negative externalities of deforestation into the decision-making process of forest land-owners and presents a compensation to the forest-owner for protection costs and foregone revenues from alternative uses. Costa Rica is the only developing country to have implemented a nation-wide PES programme and it plays the leading role in experimenting with new structural designs.

However, we find that the scheme's additionality in the delivery of environmental services can be highly improved. Currently, the program's selection process pays little attention to actual service delivery of a forest site, and it does not consider spatial differences in risk of deforestation and opportunity costs of forest conservation. This means that funds are lost to forest sites which provide few environmental services, are in no danger of deforestation and have low opportunity costs (it can be assumed that many sites could be integrated into the programme with a lower payment because application numbers of forest owners are about three times higher than funds can pay for, showing that today's fixed per ha payment exceeds opportunity costs).

For these reasons we designed a site selection tool which takes above mentioned spatial differences into account. The tool is based on geographic information system (GIS) technology. It comprises valuation scores for carbon, water, biodiversity and scenic beauty services, deforestation probabilities and opportunity costs and thus combines interdisciplinary expertise in a joint product. Data which could not be provided by secondary sources was raised in own field surveys. The tool simultaneously analyses the information of the total number of potential forest sites and employs a maximisation function to select those sites which maximise benefits at constant expenditure. To our knowledge this is the first selection mechanism that considers the trade-offs between several not perfectly correlated environmental services.

Keywords: Biodiversity, carbon-sequestration, Costa Rica, environmental services, forest conservation, market-based instrument, natural resource management, payments for environmental services, site selection, targeting, water services

Institutional Reforms in Providing Rewards for Environmental Services

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This study examines institutional reforms in providing rewards for environmental services, drawn from three different sites of RUPES (Rewarding Upland Poor for Environmental Services They Provide) in Indonesia. A combination of desk analysis and field observations to all three RUPES sites were used in the study, applying a purposive participatory rural appraisal to collect new information in the sites and to verify some information on the institutional mechanisms already available. Based on classes of institutions, societies of watershed services in Sumber Jaya of Lampung Province have adopted the norms and conventions based on the (economic) values of migrant, frontier and forest-pioneer character. Institutions supporting biodiversity services in Bungo of Jambi Province were developed based on the norms and conventions that a right to use the land is generally attainable through forest frontiers, initial planting of cash crops such as rubber and cinnamon. A revival of sophisticated *nagari* system in carbon sequestration sites of Singkarak of West Sumatra Province significantly redefines the land-use system, where the right to use land is governed through locally defined conventions within local decision-making institutions. However, the estimated transaction cost to implement the reward transfer is US\$ 55 per household, a relatively high cost for a household with average annual income of US\$ 100 or less. The component consists of costs of initiation or searching information (70%), costs of coordination or organising the group (27%), and cost of monitoring or enforcement on the group existence (3%). This also implies a non-efficient economic organisation of the society in the sites as well as non-clear institutional arrangements or policy structures at regional and national level. Therefore, roles of intermediaries such as NGO (national and international) are extremely important to reduce transaction costs, especially to ensure ordered relations and conflict resolutions, to improve trusts, shared responsibility and lifescape co-management to achieve sustainable resource management. Elements for institutional reforms to formulate rewards for the poor providing environmental services should focus on: clear, transparent, and integrated social forestry development; participatory conservation of biological diversity; and public-private partnership for water-resource management to implement catchments rehabilitation for clean development mechanism.

Keywords: Environmental services, institutional reforms

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Multi-Stakeholder Partnerships to Integrate Participatory Approaches into Institutions of Agricultural Research and Development

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In order to be effective and sustainable, participatory approaches to research and development must be scaled out horizontally to reach broader constituencies and scaled up vertically to reach higher levels of management and policymaking. This can be achieved through a concerted effort of the major stakeholder groups, e.g. men and women farmers, extension agencies, development NGOs, researchers, universities, policymakers at various levels.

An international platform of civil-society organisations, called PROMoting Local INNOVATION (PROLINNOVA), is stimulating the building of multi-stakeholder partnerships at national and sub-national level in order to institutionalise participatory approaches towards developing environmentally-sound use of natural resources. PROLINNOVA is currently active in nine countries in sub-Saharan Africa and Southeast Asia (Cambodia, Ethiopia, Ghana, Nepal, Niger, South Africa, Sudan, Tanzania, and Uganda). Stakeholders in each country have designed their own, unique country-level programme, based on local experience and history. In each case, the participatory design and implementation process is facilitated by a local non-governmental organisation (NGO) that brings together the different stakeholders to:

- collect local experiences in recognising farmer innovation and in promoting participatory technology/innovation development;
- analyse these experiences jointly; and
- develop action plans to improve, expand and integrate participatory approaches to farmer-led research and development in the major institutions of agricultural research, extension and education in their country.

These activities include action learning and policy dialogue to bring about organisational change. The learning and arguments are based on grassroots activities in promoting local innovation, achieved through recognising the dynamics of indigenous knowledge and facilitating farmer-led experimentation in collaboration with other stakeholders. Attention is given to both technical and socio-institutional innovations to improve agriculture and natural resource management.

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The paper discusses the roles of the different stakeholders in these partnerships, including the benefits and constraints of facilitation by NGOs. It examines how this approach contributes to more dynamic and site-specific rural development processes and supportive policies. It synthesises results of comparative analyses of nine country-level case studies in building multi-stakeholder partnerships for sustainable rural development carried out within the PROLINNOVA programme.

Keywords: Action learning, farmer innovation, institutional change, participatory research and development, partnerships, stakeholder interaction

Endogenous Livestock Development — Can it Help the Poor?

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The consumption of meat and milk in developing countries is rapidly rising and expected to double in the next two decades. The enhanced demand and the liberalisation of trade have started triggering the expansion of industrial livestock production in the South, promising to revolutionise and intensify the livestock sector in many developing countries. What options have poor herders and farmers if they want to continue livestock keeping in this changing context? Some development professionals recommend vertical integration and contract farming as solutions. But these strategies appear inappropriate instruments for pro-poor development as they commonly combine high labour productivity with low employment. A study conducted by the Pro-Poor Livestock Policy Initiative of the FAO suggests that the best way of supporting poor livestock keepers is by helping them build strong associations and empower them to argue for their rights. Pointing in the same direction, another study sees it as crucial to reform the institutional context of service delivery. “People-centred livestock development” (PCLD) is an approach to livestock development that puts the livestock keeper into the centre of development efforts rather than just pursuing enhanced animal production levels. It recognises the fact that pastoralist and smallholder livestock production systems are geared towards risk-aversion instead of maximising production per animal, and therefore seeks to primarily support the resilience of livestock keeping households, for instance by securing access to land and grazing rights. Recognition and respect of indigenous knowledge and local culture are important aspects of PCLD projects, as are the integration of local and modern knowledge, initiating a dialogue with politicians and scientists, linking people to support institutions and helping them explore niche markets and voice their needs. Other potential strategies are lobbying for the legalisation of informal markets, lowering animal mortality in low-input husbandry systems, and helping people to fulfil the required standards of hygiene and (zoonotic) disease control. The paper analyses such approaches and discusses their results and impacts, drawing on a pilot study of 15+ people-centred livestock projects, additional project documents and literature and field experience in several Asian countries.

Keywords: Livestock development, participatory approaches, pastoralists, people-centred livestock development, smallholder livestock keepers, sustainable development

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How Accurate Is Participatory Wealth Ranking (PWR) in Targeting the Poor? A Case Study from Bangladesh

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The UN Millennium Development Goals seek to halve the number of people living below a dollar per day by 2015. Many development policies and projects therefore seek to target the (dollar-)poor in the provision of goods, capital, and services, and use a number of poverty targeting methods. PWR is a participatory poverty assessment method that relies on local reference groups rating the relative poverty status of households in their community. This paper assesses the validity of PWR, and compares PWR scores with other poverty measures: (1) per capita daily expenditures, as measured with the Living Standard Measurement Survey (LSMS) method of the World Bank, and (2) the subjective assessment of the household's poverty status by the interviewer. We examine three questions. (1) Is there any significant correlation between PWR scores, assessment by the interviewer, and LSMS-type per-capita expenditures? (2) How accurate is a calibrated PWR-tool in predicting a household being below or above the international poverty line of one-dollar a day? (3) How does the accuracy performance of PWR change if the scores are calibrated at higher different geographic levels (e.g. district instead of community)? Using a village census in 8 villages located in four of the five divisions of Bangladesh, 1660 households have been scored using the PWR method. A randomly selected sub-sample of 320 households (40 households in each village) were interviewed with an LSMS-type questionnaire. The data allow identifying households that have per-capita expenditures below 1 dollar a day at purchasing power parity rate. Our results show that calibrated PWR scores can achieve an overall accuracy of 70 to 79 percent, i.e. up to 8 out of 10 households are correctly predicted. As expected, the accuracy is higher if the PWR scores are calibrated at lower administrative level, and highest if calibrated at the community level. For the case of Bangladesh, the results confirm the validity of PWR as a poverty targeting method for development policies and projects if used at the community level.

Keywords: Bangladesh, measurement, Participatory Wealth Ranking (PWR), poverty, targeting

Group Dynamics in Participatory Research Processes

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Activities in and with groups are a central element of participatory research processes, particularly in the most popular approach, Participatory Rural Appraisal (PRA). Ideally a research team comprises people from various disciplines, of both sexes and of different cultural origins. As regards the methods used in PRAs, group exercises are given preference over interviews and discussions with individual respondents. In the common PRA literature, these group processes are mostly regarded as key to successful engagement with local people. In practice, however, group dynamics on the side of both the researchers and the local stakeholders entail a range of challenges and potential pitfalls, particularly for young scientists. While there is a considerable body of literature on the effect of power differentials among local stakeholders on the process and outcome of PRA exercises, there is a lack of empirical studies on the impact of group dynamics within the research team itself.

This paper analyses social dynamics in interdisciplinary and intercultural research teams. It draws on experiences with several trainings and pre-tests of participatory research activities in the context of a collaborative agricultural research programme focusing on sustainable land use and rural development in mountainous regions of Thailand and Viet Nam. I participated in these events, which took place between 2001 and 2005, either as a co-organiser and facilitator or as a participant observer. The analysis of the social dynamics in the research teams draws on group relations theory which comprises certain core definitions, namely (1) task: what the groups wants or needs to achieve, (2) boundary: who is recognised as a member, (3) role: in which ways do group members act, and (4) authority: who is entitled to do certain activities.

Findings suggest that failures and dilemmas of many well-intended participatory inquiries are largely the result of unclear agendas, dissenting objectives, distrust among participants and the fear of losing one's voice in the research process. Common goals, mutual trust and democratic inquiry in participatory research teams can thus not be taken for granted, but require transparency of tasks, definition of boundaries among group members, clarification of roles, and a constant (re-)negotiation of authority.

Keywords: Group dynamics, group relations theory, participatory research processes, research teams

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Impact Orientation of Agricultural Research in Eastern and Central Africa

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The development and management of food chains is a priority in many developing countries. Its driving forces are urbanisation, growing market shares of supermarkets and the demand on agricultural research to contribute more to creating wealth among the rural poor. Those who want to develop or optimise food chains depend on knowledge and services from agricultural research such as market information or technology and management options that are required to meet international grades and standards. Serving their needs requires a renewed culture of impact orientation.

In January 2005, twenty senior researchers from ten national agricultural research institutes (NARIs) in Eastern and Central Africa met, to deliberate on how research institutes could increase the probability of achieving development impact with their research. The development of food chains, value addition and competitiveness of agricultural production are priorities in the region that call for new partnerships and alliances since other actors also influence knowledge and innovation. They require approaches that combine science with the development and adaptation of technology and link up to comprehensive commercial strategies. The participants asked: “How would one recognise an agricultural research institute that is impact-oriented? What would it ideally look like?” They came up with a range of characteristics and found that impact orientation rests on four key pillars:

Pillar 1: Client Orientation and Policy Dialogue (social demand).

Pillar 2: Planning, Monitoring and Evaluation, and Impact Assessment.

Pillar 3: Management of Research Resources.

Pillar 4: Management of Linkages and Partnerships with Stakeholders.

NARIs in the region demonstrate different levels of impact orientation. While some are well ahead in one area, they are also deficient in others. The paper presents a summary of the strengths, weaknesses, opportunities and threats to impact orientation in the 10 member countries of the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA). Opportunities for sharing of experiences and forging of networks to tackle common interests are explored.

Keywords: Impact orientation, research management

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Global Value Chains in Development Cooperation

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Value Chains for Growth and Poverty Reduction in Developing Countries

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Value chains linking agricultural production in developing countries with world markets seem promising, both in terms of broad-scale and sustainable economic growth but also with respect to poverty reduction. However, whether or not these impacts are positive depends, on the one hand, on international trade agreements and regulations and, on the other hand, on the modus operandi for integrating producers into value chains.

The development potential of export-oriented agriculture is widely determined by the conditions of trade. Unless agricultural policies in the North continue to bring down subsidies for their production and export, and trade policies open the way to higher value imports, agricultural exports from developing countries will remain critically limited. Nevertheless, commercial farmers in developing countries already benefit from diversification into those chains that are less affected by unfair trade policies. In addition, the ongoing trade negotiations are about to generate new commercial opportunities for producers in the South.

Global value chains in the agro-food sector are frequently dominated by big import or retail companies or by agro-industry. While the co-operation with lead firms often is the only chance of winning market access, chain integration may easily get in conflict with social and ecological goals. The structure of chains and the distribution of market power affect the distribution of risk and gains across chain partners.

Even if the conditions of world market integration are acceptable, not all small-scale farmers will be able to achieve and maintain a competitive position in agribusiness. Besides the issue of chain governance, development cooperation faces a growing problem of economic exclusion, especially of farmers in marginal rural areas. Provided the export growth involves transformation activities that add value in the exporting economy, spill over can generate pro-poor effects. Selecting a promising export product for promotion requires screening the potential growth-poverty reduction linkages.

Keywords: Agricultural trade, development cooperation, exclusion, governance, marginalisation, poverty reduction, value chains

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Value Chains in Developing Countries: Research Situation and Relevance to Development Policy

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In international trade anonymous transactions negotiated in a market are becoming less and less frequent. An ever growing share of the worldwide exchange of goods and services is handled through long-term agreements on quantities, delivery periods as well as product and process standards. At the same time, there is a global concentration process going on in most markets. As a result, large production and trade firms (“lead firms”) have more buying power and therefore more opportunities to enforce compliance with their wishes in international value chains. They define standards and enforce them over their value chain partners. Frequently, they push the concentration process within the different supply levels in order to make economies of scale and reduce coordination costs. They often use their predominance in order to beat down their partners’ margins, thus increasing their own profits.

Higher standards, increasing necessities for coordination, progressing concentration of enterprises and increase in power of the lead firms raise the barriers to market access for enterprises. Especially small firms from developing countries run the risk of being excluded from international value chains or, at least, having their share in the profits from value adding processes reduced. On the other hand, global value chains offer chances to gain access to big international markets and to state-of-the-art know-how. Some of the lead firms contribute considerably to technology transfer.

As a consequence of these processes, new approaches including new partnership constellations have to be promoted in development cooperation. The new tasks are, amongst others, the setting-up of socially non-exclusive certification systems or the support of developing countries in international negotiation processes. The presentation gives an overview of the structural changes in selected agro-industrial value chains and their implications for integrating smallholders, addressing equity issues and initiating technological learning processes.

Keywords: Development cooperation, global value chains, governance, international trade, lead firms, smallholders, technology transfer

Value Adding through Standards? Chances for Small Farmers Groups Producing Organic and Conventional Mangoes for Export Markets — A Comparative Analysis

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Do standards add value to the produce and who will reap the benefits from standard implementation in the value chain? Will standards help increase incomes of small farmers in developing countries or are they so expensive to implement that small producers risk to be excluded from export markets?

These key questions are examined in an exemplary way for organic and conventional mangoes delivered to the same type of retail outlet. Considerable differences can be observed regarding actors, their relationships and the basic rules which define the conditions for participation in the two chains. On top of quality, price and delivery reliability compliance to internationally agreed standards is increasingly required. In the conventional mango chain, the EurepGAP standard and the International Food Standard (IFS) are defining good agricultural respectively manufacturing practices. Organic production and processing are regulated in EU regulation 2092/91.

Producers need knowledge and practical skills regarding the requirements of the standards, their implementation and conformity assessment procedures. In general, groups of growers have advantages in managing the know-how transfer and certification process in a cost-effective way. For both conventional and organic mangoes, there is a large variety of schemes such as cooperatives, contract farming or outgrower schemes that are making certification viable and affordable but simultaneously often increase the dependence of suppliers on their customers.

Organic certification offers opportunities for small farmers on both export and domestic markets if technical assistance is provided. Many studies state positive income effects for organic farmers. In contrast, supplying certified conventional produce will not result in producers receiving premium prices in their target markets. It may help a minority of growers to obtain more business due to enhanced quality and business management capabilities but is not a realistic option for the majority of small farmers in developing countries.

Keywords: Developing countries, EurepGAP, group certification, international food standard (IFS), mangoes, organic farming, outgrower schemes

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Bio Fuels — Innovative Value Chains in Development Cooperation?

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Despite permanent projections of raising food commodity prices, the prices for food commodities remain stable or fall. As the purchasing power based demand for food in most parts of the world is not increasing, but production increases are significant, the effects turn agricultural prices downwards.

Despite of millions of people suffering from hunger, for the world market reactions on food prices, these people are irrelevant. On the other side, millions of farmers suffer from de-pressed agricultural commodity prices due to a high market pressure caused by an ample supply.

As the demand in the food sector for agricultural products seems to be satisfied, other demand areas have to be taken into account. One is the use of agricultural commodities as a source of renewable energy.

The Bio energy market is forecast to show significant growth as current environmental drivers are increasingly supported by fundamental commercial interests. The most significant change is likely to come from an increase in energy prices. The increase of costs of conventional energy improves the competitive position of bio energy as a power source.

For the farmer in developing countries bio energy (for heat, electricity and transportation) may become a significant source of income generation. The emerging new value chain remains to be shaped to fulfil the criteria of sustainable development. Examples, criteria, and options are discussed.

Keywords: Bio fuel, commodities, development cooperation, innovative value chains, renewable energy

Shaping Value Chains for Development — Practical Experiences

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Current development thinking attaches great importance to market-led economic growth for poverty alleviation. “Pro-poor growth” has become the leitmotif running through much of the recent development debate. In the field of agricultural development, pro-poor growth is increasingly associated with small-scale commercial agriculture. A key concept is the development of value chains integrating farmers into high-value markets.

The move to a strictly market-led agricultural development philosophy revives the interest in the social and institutional aspects of cash crop production. After all, “supply chain management” has its origin in the private sector and is clearly linked to the modernisation of retailing and the rising significance of food quality requirements. The question is to what extent “value chain development” can in fact serve as a core concept of rural development.

Within the international development community there is widespread agreement that poverty alleviation will not be achieved without effectively functioning markets. Rural development strategy should focus on correcting market failures that discriminate against rural producers and invest in efficient market institutions by advocating legal regulation, strengthening service provision, intermediating between farmers, input suppliers, traders, companies and rural banks, and by building infrastructure. Some of these interventions being specific to particular product markets, they provide the basis of a value chain strategy. The idea is that market-led development generates the income sustaining itself.

However, the trade-off between growth and poverty alleviation remains, as more efficient markets drive out less competitive producers. So it is by no means clear to which proportion the rural poor will eventually benefit: Value chain development is a necessary condition, but by itself not sufficient to respond to the problem of economic exclusion. A value chain perspective helps to explore the growth potential of specific rural products and allows targeted interventions activating it.

Keywords: Intermediation, market failures, market-led agricultural development, rural development strategy, service provision, value chains, pro-poor growth

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Changing Views of Innovation and Design — New Roles for Extension in Trans-Disciplinary Encounters

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Since the work of Everett Rogers, theories about the adoption and diffusion of innovations have continued to inform scholars and professionals in the field of 'extension'. In recent years we have witnessed the emergence of new theories and modes of thinking about innovation and innovation processes. Innovation is increasingly seen as a co-evolutionary process that involves simultaneously different human and agro-ecological aggregation levels. Network building, social struggle and social learning appear to be key ingredients of innovation trajectories. This presentation introduces these conceptual shifts and discusses their implications for the role of both scientists and communication professionals in socio-technical design trajectories. Subsequently, the presentation draws attention to incompatibilities between, on the one hand, increasingly privatised arrangements for the funding of research and extension, and, on the other, the novel roles as derived from recent innovation theories. It is argued that, in practice, the discourse of 'demand driven service delivery' can easily lead to interaction patterns that hinder the flexible cooperation, learning ability, pro-activeness and creativity that is necessary in order to enhance innovation. Institutional change and a rethinking of the notion of 'demand articulation' are needed to move ahead. Examples from the Netherlands and Ghana are used to underpin and illustrate the arguments made.

Keywords: Innovation theories

The Agricultural Knowledge System in Tigray, Ethiopia: Empirical Study about its Recent History and Actual Effectiveness

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Policies conducive to the development of the agriculture sector in Ethiopia are laid down. According to the Agricultural Development Led Industrialisation (ADLI), the development of the agricultural sector is to serve as the engine for the overall development of the economy and the government is dedicating tremendous efforts to achieving greater progress in this sector. The ADLI strategy depends on improved agricultural packages, proper use of land and water resources, access to improved rural finance, better functioning markets and better roads. Along the lines of the Sasakawa Global 2000 (SG 2000) agricultural programme in Africa, the Government of Ethiopia has launched a National Extension Intervention Program to feed into the ADLI strategy. The national extension programme is implemented throughout the country based on the principles and approaches of the SG 2000 program.

Based on empirical findings using narrative interviews and focus group discussions, the study explores the current situation of extension services in Tigray. The paper first describes the socio-economic, agro-ecological, institutional and human resources factors which affect the performance of the agricultural knowledge system in Tigray. The paper then reviews the history of agricultural extension in Tigray and analyses the organisation and functions of the agricultural knowledge system in the region. The paper identifies critical gaps in the planning and implementation of the extension package programme and describes farmers' adaptations of introduced packages. Further, the paper discusses farmers' perceptions of the roles and competences of development agents and the use of model farmers.

The paper also explores institutional coordination and information flows between the various rural development actors in the region. It examines the potential synergies which could be gained from close collaboration between extension, input supply, credit and marketing systems. It also discusses the roles of agricultural research and education in the agricultural knowledge system in Tigray. The study observes that current policy frameworks and institutional arrangements have laid the foundation for improving the effectiveness of the agricultural knowledge system in Tigray region.

Keywords: Agricultural education, agricultural knowledge system, agricultural research, extension services, institutional coordination, Tigray

The Contribution of Individual and Group Social Networks to Knowledge Diffusion among Farmers in Semi-Arid Kenya

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Following the radical change of the extension sector in eastern Africa that was triggered by the disproving of the traditional ‘Transfer of Technology’ paradigm in the 1990s, a number of competing and largely decentralised extension approaches have been developed. Basing upon the hypothesis that innovative arrangements and practices emerge from social interaction rather than from the traditional technology development chain, most of those new approaches aim to facilitate exchange and networking among farmers, research and extension organisations. From the coexistence of traditional and alternative approaches arise the need for, and the opportunity of comparative evaluation and impact assessments.

The paper investigates the diffusion of innovative farm management technologies in two rural development projects that follow dissimilar extension approaches. Household and community-level social networks, as well as the regional Tree Knowledge and Information System (TKIS) represent the analytical levels of analysis.

A full sample of 432 households has been interviewed in West Pokot and Makueni Districts of Kenya. Primary data was collected using semi-structured questionnaires, expert interviews, group discussions and rankings, as well as observation. Data was analysed employing sociometric and statistical software packages.

Farm household innovativeness is related to the household information and exchange networks, as well as the activities and maturity of development-oriented village organisations and farmers groups. Institutional interlinkage and collaboration between administration, research and extension organisations are presented. Research findings are captured in a statistical model. Recommendations refer to the intensification of farmer-to-farmer knowledge exchange, in order to further improve efficiency and efficacy of the technology extension efforts.

Keywords: Agroforestry, diffusion of innovations, forestry extension, social connectedness

Integrated Pest Management (IPM) and Information Flow: Case Study Tomato Stakeholders' Practices in Kenya

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Small holder horticultural farmers in Kenya, producing both for local and export markets, are faced with challenges arising from changes in consumer demands and environmental awareness concerns. This stems directly from over reliance on chemical pesticides for pests and diseases control. Currently, various pests and diseases control methods are being tested, all aimed at being used in an integrated pest management (IPM) approach. The approach is site specific and knowledge-intensive, hence effective information flow and management are fundamental tenets towards its success. The study is based on interviews with tomato-growing farmers in Kenya. The study assessed existing tomato IPM practices; IPM information management practices; IPM social networks among stakeholders and IPM communication media. Descriptive statistics and social network analyses were undertaken. Preliminary results show that tomato diseases (wilts and blights), thrips (insect pest), red spine mites, and nematodes were the most important production constraints reported by the farmers. Majority (over 80 %) of the farmers interviewed were not aware of the IPM approach, though a significant number practices various IPM components. Majority of the tomato farmers (over 50 %) reported spraying pesticides frequently mainly for common pests and diseases. Other practices mainly indigenous technical knowledge (ITKs) are used in cases of newly emerging tomato pests and diseases. Biological control agents and legislation regulations were not reported to be practised from the study. The most important medium of communication used is verbal. A significant numbers of farmers interviewed keep pest management information in memory. Social network analysis was undertaken using UCINET program. Results show that the density of social relations influence IPM stakeholders interaction behaviours inducing various structural patterns of connections. Implications towards IPM implementation and effective information flow in Kenya are discussed. The study is anticipated to contribute towards improvement of integration and communication of pest management information leading to effective crop protection in Kenya

Keywords: Asymmetrical information, integration, IPM, Kenya, relations, social networks analysis

Forest Management Policies

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Forestry Production Systems in Change: Myth and Realities

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The development of forest production systems is triggered by exogenous framework conditions like markets, rules and infrastructure. Further exogenous influences are rooted in the prevailing guiding trends, visions and fashion, which often have no scientific base. The endogenous driving forces are institution and capacity building, technology innovation and diffusion. Forest production systems development is a complex iterative process responding to exogenous and endogenous factors and involving long term learning cycles.

In the last development decades forestry production systems have diversified and changed rapidly. Besides conventional production systems like natural forest utilisation under state or concession management, private plantation forestry or farm forestry and community forestry, new institutional arrangements like joint forest management and diverse systems of Non Timber Forest Products (NTFPs) use have emerged. A huge number of case studies on different systems is available. The elaboration of an overarching dynamic framework, which permits a future oriented classification of forest production systems and their valuation by a SWOT analysis are seen as promising further steps.

Rooted in a genesis of forestry production system development, outstanding case studies of forest management systems are presented, discussed and first steps of a key-indicator based SWOT analysis are undertaken. Some of these systems are presented in detail in the contributions of the session. In some cases the long term outcomes of the particular system are still under discussion, as in case of private natural forest management initiatives in Brazil. In other systems outcomes are overvalued, as in the case of some Non Timber Forest Product based systems. Special emphasis is put on community forestry systems in South East Asia. The keynote is a plea for a better categorisation of forest production systems in an overarching framework and a continuous monitoring of their development. Conclusions permit an outlook towards promising pathways of forest production system development.

Keywords: SWOT analysis, Non-Timber Forest Products

Traditional Property Rights and their Influence on Forest Resource Utilisation in Ethiopia

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Ethiopia's mountainous moist forests have witnessed high rate of deforestation during the last decades, for which scholars primarily blamed total 'open access' regimes. Nonetheless, research revealed that forest land is almost entirely divided into plots traditionally owned by local peasants. Thereby, forest use property rights determine who of a community is allowed to use which forest products to what extend. Which forest resources are thereby individually 'owned', and which ones are subject to 'open access' vary significantly. Collection of dry firewood, for example, works on a basis of 'first come, first served', whereas utilisation of timber and cash crops is mainly dominated by exclusive right ownership. Generally, the more valuable a product is, the more limited is its open access character.

Traditional forest use property rights base on informal community-based 'juridical' institutions, such as the 'elders', which guarantee persistence of use rights, serve as conflict solution bodies, and provide rules and regulations shaping utilisation of specific forest resources. These institutional arrangements allow appropriation of forest plots by patrilinear inheriting and disposal by sale. In principle, traditional forest land property rights continue to reflect distribution pattern from feudal landlord system, prevailing forest ownership and use prior the revolution in 1974.

Nevertheless, ever since revolution, Ethiopian governmental land tenure policy does not foresee individual forest ownership, as all land is designated to be 'common property of the Nations, Nationalities and Peoples of Ethiopia and shall not be subject to sale or to other means of exchange' (Ethiopian Constitution). This incompatibility of official governmental land policy and traditional forest property rights illegalises the latter and brings up multiple conflicts which drastically weaken forest conservation efforts.

This study provides empirical findings from two villages in the mountainous moist forests of Southern and South-western Ethiopia, and positions them into the broader framework of forest resource use and conservation policies of Ethiopia. It concludes with impulses and suggestions of how traditional forest use property rights — instead of being illegalised — may rather be incorporated into forest conservation projects.

Keywords: Ethiopia, forest conservation, forest property rights

Accessing to Forest Products: A Commodity Chain Analysis on Timber in Northern Uplands of Viet Nam

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Property relations in the Viet Nam took a sudden turn after the implementation of ‘Open Door’ policy — when Viet Nam shifting from central-planning economy to market-oriented one - in 1986. Regarding forestry, under the forest land allocation policy, the Vietnamese government allocated forest land to individual households. By giving more control over the land to local people, the government hope to improve existing forest conditions and at the same time to strengthen local livelihoods.

This paper applies commodity chain framework to analyze how the timber is exploited in the village and brought to the lowland market for sell. It looks into who actually benefit from timber, and how. The paper shows that villagers in a northern upland village locating in a critical watershed area is still heavily engaging in timber logging regardless government policy which bans timber exploitation. Timber is then brought to the lowland market through a completed web of checking points set up by government to stop transportation of timber. During the chain, there are many different actors involved, and there has been an unequal benefit sharing among different actors — villagers/loggers, transporters, middlemen in the uplands, and sellers in the lowland market, and various government officers who are working at checking points or are serving in forest-related institutions. In this process, villagers are the ones who benefit least.

The paper questions the linkage between private property and forest protection in a post-socialist country. It shows clearly that the defined rights and obligations on forest determined by private property (under the implementation of forest land allocation) do not help protect existing forest resources as villagers still believe forest resources are common property. This form of property provides villagers access to forest resources particularly timber. In this legal pluralism context, access to timber of the household is determined not by property rights defined by the government, but mainly by access to water buffalo and labour availability in the house.

Keywords: Commodity chain, property, timber, Uplands, Viet Nam

Will Wood Processing Enterprises Save the Rain Forests? Their Potential to Contribute to Sustainable Forest Management in the Amazon

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The introduction of sustainable management of natural forests is a major strategy to protect the tropical forests of the Amazon region. Wood processing enterprises are key stakeholders in the forest management process and their needs have to be considered when policy concepts for the implementation of sustained management are designed.

So far, sustainable management of natural forests has not yet achieved significant importance in the region. Studies of first pilot projects report on financial difficulties and present the economic prospects of sustainable forest management in a rather pessimistic light.

Whereas microeconomic theory assumes that private enterprises give priority to financial targets, sustainable forest management requires the combination of ecological, social and economic targets in the enterprise policy. Still, the question remains open, under which conditions wood processing enterprises in the Amazon would be able to implement sustainable forest management.

Basing on three case studies of wood processing enterprises in the Amazon region, the study presents constraints and opportunities of the implementation of sustainable forest management practices. The focus of the investigation is put on the interrelation of forest management, wood processing and timber marketing. To do so, the financial and economic impacts that result from the compliance with social and ecological standards have been studied. Data collection involved semi-structured interviews of enterprise stakeholders, as well as accounting data from the enterprises. A financial model was elaborated to develop profitability sensitivity analysis using Crystal Ball software.

The results prove that compliance with standards of sustainable forest management is NOT the most important factor for the economic success of the enterprises in question. Instead, wood processing and manufacturing processes, as well as marketing efforts determine the economic profitability.

The financial analyses of wood processing enterprises that engage in sustainable forest management show a low, but positive profitability. Apart from economic profitability, managers and stockholders of the case study enterprises, however, possess additional motives to implement sustainable forest management, such as stable round wood supply.

It is concluded that policies that are intended to promote sustainable forest management have to consider the enterprise sectors other than the forest management component as well.

Keywords: Amazon, Brazil, certification, sustainable forest management, timber industry

Forest Extraction and Product Marketing of Selected Dweller Systems in Várzea and Terra Firme Locations of Pará State, Brazil

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Estimates on the number of people involved in forest extraction in the Amazon region range from about 1 million to over 500 million. The ambiguity on the definition of forest extraction can explain much of this discrepancy. Studies that bring together the productive activities of forest dwellers and uses of the respective products are still rare. In the context of a Farming Systems Analysis an exploratory study was undertaken focusing on the contribution of forest extraction to the livelihood of dweller households in selected locations at the lower Amazon river. The objective of the study was to contrast practices and output of dweller households in the Várzea and Terra Firme regions. The study sites were identified basing on criteria like accessibility, ongoing extraction of forest products, and ecosystem. A total of 60 households, among them 12 in Itacoã (Terra Firme) and 48 in Monte Tabor, Nova Santa Cruz, Manoel Carneiro (Várzea) had been selected for primary data collection.

Results prove common and also differing characteristics of the study sites. Similarities across the study areas are the household orientation towards sustenance, small-scale production, absence of land titles, and exploitation of forests as an open access resource. Both the production for home consumption and commercialisation contribute to this effect. Particularities of the studied Terra Firme location are shifting cultivation combined with charcoal production for sale, individual household arrangements, and access to the Belém regional market place. The Várzea communities under study are characterised by limited agricultural activities due to seasonal inundation, inefficient home gardening, timber and palm heart extraction in Várzea and adjoining Terra Firme areas as the main cash-generating activities, local sawmilling for value addition, dependency on middlemen for marketing due to the location far from Breves and so Belém market places and communal household arrangement. Despite the more variable production system in the studied Terra Firme location the mean income per person is distinctly higher in the Várzea communes due to timber extraction. Forest related recommendations put emphasis on land titling, participatory assessment and management of the resources referring to the productive capacity.

Keywords: Adding value, commercialisation, forest extraction, home consumption

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Is the Watershed the Problemshed? Approaches to Issues of Water Scarcity in Arid Zones

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The purpose of the paper is to emphasise that water problems are often addressed outside the water sector. This is especially true for economies that share watersheds that have insufficient water to meet the needs of an irrigation sector to achieve food security. The analysis will draw attention to the types of water available - soil water and freshwater (surface and groundwater) and virtual water and manufactured water. The very important economically invisible and politically silent processes, which make food and water security possible, will be discussed. These processes are firstly, the utilisation of the surplus soil water in the temperate regions to produce staple grains, secondly the movement of these commodities into water deficit regions with the impact of virtual water, and thirdly the process that enables these first two processes to take place - namely socio-economic development in the water scarce economies. The Jordan Basin is a laboratory which provides very strong evidence that the solutions to water sector problems lie outside the watershed.

Keywords: Jordan Basin, water problems, water security, virtual water

Integrated Science for Sustainable Water Management in the Jordan River Basin

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Existing approaches in the Jordan River basin for water resources management under global change and globalisation suffer from a lack of integration, in particular with regard to operational linkages between relevant disciplines and between science and application. For example, socio-economic projections and scenarios require more information on biophysical effects of different management options, in particular with respect to water quality and quantity. Natural sciences often focus on areas that are not central for

policy- and decisions-making in regional water resources management and development. Both scientific branches have to respond to the requests from water managers for representative spatial information .

Scientists from Germany, Israel, Palestine and Jordan try to overcome these gaps in an interdisciplinary co-operation within the BMBF funded GLOWA (Global Changes in the Hydrological Cycle) Jordan River project. The study region is densely populated with people of three nationalities. It hosts a variety of dryland eco-systems that preserve genetic resources and provide a range of ecosystem services. Per-capita water availability is already among the lowest worldwide in terms of quantity and adequate quality; and the demand-supply gap will widen further, e.g. due to the expected climatic changes in the Mediterranean and rapid demographic development. Integration of disciplinary research e.g. through coupled models, geographically explicit quantitative scenarios, continuous stakeholder participation and a dedicated decision support system does not only synthesize new and applicable knowledge for the study region, but also add experience for transfer of approaches and results to other dryland regions.

Initial applications of the WEAP (Water Evaluation and Planning) tool and SAS (Story and Simulation) scenarios, jointly between scientists and stakeholders, focus research and data consolidation on the real requirements for integrated water (and land) management.

Keywords: Agriculture, ecosystems, DSS, global change, GLOWA, green water, IWRM, Middle East

Glowa Jordan River - Challenges and Approaches in Building the Bridge on Water-Related Research Between Socio-Economists and Natural Scientists in a Multi-National Environment

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National and international political developments and relationships of power highly affect decisions on water resources management in the Jordan Valley. But demographics and the therewith intimately connected parameters of living standard and functionality of local social groups set essential cornerstones of the potential room for political manoeuvre. Findings of a network of regional and German social scientists indicate that changes in water arrangements are likely to have wide-ranging and complex impacts on the socio-economic carrying capacity of the region. Predominantly affected occupations are those that are linked to agriculture due to its outstanding role in providing livelihood and, simultaneously, its extremely high proportion in water consumption. Repercussions on adjacent fields of lower direct socio-economic importance, such as e.g. ecological systems and small-scale industries, may become crucial if their comparatively minor, but probably indispensable contributions to the carrying capacity, fall below critical, hitherto unknown thresholds. Analyses of existing databases and model scenarios cope with this bottleneck by applying general assumptions instead of precise, locally specific knowledge. The therefore obviously required interdisciplinary research faces the challenge of defining potential cause-effect-chains from biophysical and biochemical changes up to socio-economic parameters in a scientific environment, which is burdened with the difficulties of overcoming the barriers between the so-called 'two cultures' of natural and social sciences. The challenge becomes even more complex, if — as given in the Jordan Valley — political and social frame conditions set limits to the harmonisation of research methodologies of the different partners within scientific disciplines. All three problem areas, i.e. the need for defining cause-effect-chains as well as the aspects of inter and intra-disciplinary cooperation, find their exemplary expression in the set-up of the BMBF-funded project GLOWA Jordan River. Approaches for resolution have to meet the individual problems as well as their interactions by an accordingly complex set of measures, which range from structural adaptations, methodological compromise and communication mechanisms up to the mutually accepted delimitation of areas of competence and exchange.

Keywords: Interdisciplinary research, Jordan Valley, socio-economics, water

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Water Resources under Global Change: Process-Based Hydrological Modelling for the Lower Catchment of the Jordan River

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Downstream of Lake Kinneret the climatic regime of the Jordan river catchment changes to semiarid or even arid conditions. Hence specific tools are required to cope with enhanced spatial and temporal variability of rainfall and adequate modelling of generated overland flow by saturation or infiltration excess.

To simulate climatological variability, historical extremes (dry and wet seasons) are modelled using C-band rainfall radar data as model input. A parsimonious model concept (the ZIN-model) was successfully tested in a neighbouring 680 km² catchment. It was run both in a single event and continuous mode using a constant set of field derived parameters. When model runs were started at high antecedent moisture conditions, single event simulations were promising, while longer term continuous simulations were less accurate both under- and overestimating the catchment scale runoff response. For the Jordan River it is envisaged to couple this process-based approach with the hydrological model TRAIN. This model focuses on the continuous simulation of processes at the interface between soil, vegetation and atmosphere and thus helps to identify e.g. water use from vegetated surfaces and related water stress conditions. The model combination leads to improved simulations of longer term components (evapotranspiration, soil moisture, ground water recharge) of the water cycle. As such, detailed patterns of available water resources for historical extremes are expected. These will be correlated to climatic change scenarios to arrive at sound estimates of induced changes in water availability all across the lower Jordan river, which will finally be used as input for the central integration tool WEAP of the GLOWA-Jordan river project.

Keywords: Jordan River , process-based modelling, rainfall radar, runoff generation

Green Water and Natural Ecosystems under Global Change

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Scenarios of global change have fostered many studies which attempt to predict species response to climate change based on bioclimatic envelopes. These studies assume that species may simply shift their distribution when climate changes. However, such an approach completely neglects the ecological context of a species. Therefore, mechanistic studies are needed which address both responses of populations and entire communities to global climate change.

Here, we present an interdisciplinary study within the project GLOWA Jordan River which has been designed to predict the response of Eastern Mediterranean ecosystems to climate change at the level of species, communities, and landscapes. To this end, we regard ecosystems as users of 'green water' and model their response to changes in green water availability. We combine detailed field studies on soil and vegetation in naturally and experimentally varying climates with ecological modelling and socio-economic studies. Namely, we compare ecological processes along a steep climatic gradient ranging from extreme desert to humid Mediterranean conditions, and we manipulate annual rainfall at two of the stations. Spatially-explicit models integrate field data and downscaled climate scenarios for predicting the long-term response of ecosystems to climate change. Models are coupled both with models of climatic scenarios as well as with models of green water availability.

Our modelling studies indicate that changes in rainfall variability may have more drastic consequences for extinction probabilities of plant species than changes in amount of annual rainfall. In addition, our results suggest that transitional ecosystems may be the most vulnerable to climate change. Semi-arid ecosystems were most sensitive to erosion and to extinction of selected annual plant species. Since our socio-economic studies have shown that mitigation costs of climate change effects may be relatively low for those ecosystems, we suggest that management efforts should focus primarily on semi-arid regions.

Keywords: Eastern Mediterranean, ecosystems, global change, GLOWA Jordan River, Israel

Coupled High Resolution Climate - Hydrology Simulations for the Upper Jordan Catchment

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Sufficient freshwater availability is a central prerequisite for agricultural and industrial development in the water scarce environment of the near east. Political peace in the region is strongly linked to the satisfactory compliance of increasing water demands. Sustainable management of water resources requires scientific sound decisions on future freshwater availability, in particular under global climate change and increasing greenhouse gas emissions. Behind this background, the impact of climate change on water availability in the Upper Jordan River catchment (UJC) is investigated within the framework of the GLOWA-Jordan river project (www.glowa-jordan-river.de). A focus is set on the Upper Jordan in this study as it provides 1/3rd of freshwater resources in Israel. This is achieved by high resolution coupled regional climate — hydrology simulations. Two 30 year time slices (1960–1990 and 2070–2100) of the global climate model ECHAM4 are dynamically downscaled using the non-hydrostatic meteorological model MM5 in three nesting steps with resolutions of 54 km, 18 km, and 6 km. Recent emphasis is put on emission scenario B2. The meteorological fields in turn are used to drive the physically based hydrological model WaSiM applied to the UJC. The hydrological model computes in detail the surface and subsurface water flow and water balance in a horizontal resolution of 90 m and dynamically couples to a 2-dim numerical groundwater model.

Preliminary results of the regional climate simulations are presented. The ability of the hydrological model to describe the observed river discharges in this hydrogeologically extremely complex region is discussed.

The methodology presented can be applied to any region in the world.

Keywords: Distributed hydrological modelling, dynamic downscaling, regional climate modelling, water availability

The Rainforestation Farming Concept

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Land Rehabilitation in the Tropics with Indigenous Tree Species: Economic and Ecological Considerations and Research Needs

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In order to restore degraded (grass-)land in the humid tropics, indigenous tree species become increasingly important in agroforestry and other land use systems. The timber tree species still come from forest remnants and have mostly never been cultivated before. Knowledge on their ecology is fragmentary at best, and economic expectations are based on experiences from the exploitation of primary forests. In this contribution we present observations and results from existing plantings in Leyte (Philippines) concerning **(a)** growth performance, **(b)** reproduction, and **(c)** pest susceptibility of trees.

· **(a)** The description of tree habit and timber properties and quality is based on individuals from primary forests. Especially legumes are described as providing excellent timber. But, when planted - besides slow growth - they perform poorly, tending to develop forked stems and shrubby habits, which do not fulfil the economic expectations. The question arises if this is already the result of genetic erosion or just a matter of management and site selection.

· **(b)** Maturity and reproduction of tree species occurs relatively late in primary forests. In the Leyte State University's "ecoparc" trees, including dipterocarps, could be observed fruiting at an age of 10–12 years. Early reproduction of valuable species provides the opportunity to sell seeds and seedlings and to be independent from forest sources which are often costly to monitor and harvest. An important and largely unsolved question is how these species are pollinated since the trees are outside their natural forest habitat and far away from the next mother tree. If the species participate in the species' gene flow, this would mean an important contribution to retain the species' genetic diversity.

· **(c)** It is generally assumed that native species are less susceptible to pests than exotics. Results show that even native species can suffer from relatively high infestation. Again, legume trees seem to be especially prone to damages. To ensure a successful and sustainable production, the responsible pests as well as mechanisms (e.g. species-specific susceptibility, planting stress, wrong habitat selection) need to be analysed and understood.

Keywords: Land rehabilitation, native tree species, performance, pest susceptibility, reproduction

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Seed Dispersal and Predation Across a Grassland-Forest Ecotone in Southern Palawan, Philippines

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In many regions of South-East Asia, anthropogenic grasslands have replaced the original forest vegetation, particularly in the Philippines. Attempts to restore a tree cover, have been many-fold and often unsuccessful. Given the high percentage of zoochorous species among woody pioneers in the Philippines, animals as seed dispersers and seed predators are likely to play a major role in the natural succession of grassland. These animals, however occur in much higher densities in woodlands compared to ecosystems widely lacking woody vegetation.

Using seed traps and artificial exposure of protected and unprotected seeds, we compared quantitatively seed precipitation and post-dispersal seed predation in grassland and forest as a function of the distance to the ecotone. Humidity, day-temperature close to the ground and fine root density were measured at each seed trap station.

Seed precipitation was highest within woodland and gradually decreased in grassland with increasing distance to the forest. Seed predation was highest close to the ecotone and lower within forest and grassland. Humidity was lower and day-temperature was higher in grassland compared to forest. Density of fine roots was significantly higher in grassland than in forest.

Lack of seed dispersal could not explain the arrested succession in grassland. Seed predation may reduce tree recruitment, particularly close to the ecotone. Other factors, like microclimate or root competition are likely contributing to the low recruitment of woody plant seedlings.

This implies that rehabilitation of such areas by natural means cannot be expected in a comprehensible time frame, but needs interventions by man, which help woody plants to establish and thus to regain ecological and economic productivity.

Keywords: Arrested succession, grassland, land rehabilitation, natural succession, seed predation, seed dispersal

Ethnobotanical Survey in Leyte, Philippines, and Comparison with Indigenous Filipino Plant Lore

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Presented are the results of ethnobotanical fieldwork among members of Cienda San Vicente Farmers' Association (CSVFA) who are involved in community-based forest management on the foothills of Mt. Pangasugan on the island of Leyte, Philippines. The farmer's knowledge on useful plants is compared to that of four indigenous groups from the Philippines. Overall, 123 plant species belonging to 90 genera and 53 families were documented to be used by the farmers for 77 different purposes including 42 human ailments. The predominant lifeforms are trees and herbs and more than 60 % of all recorded species are native to the Philippines. Many species are used for more than one purpose: 80 plants have medicinal value, 34 provide food and 32 serve for other uses. For the indigenous people mainly plant species utilised as food and construction material are recorded. Perhaps as a consequence of different species composition in the respective regions, less than 15 % of the plant species recorded for each indigenous group are also used by the farmers in Leyte. Some medicinal plants are used in the same way by the indigenous and non-indigenous people in the Philippines indicating that their use is based on pharmacological activity. The recorded plant resources could serve as an alternative source of income by integrating such plants into sustainable land use systems. In conclusion, CSVFA farmers use a diversity of plants and have acquired a high degree of knowledge on useful plants within their environment. This study provides a base for enhancing scientists' attention towards consideration of non-indigenous rural folks as source of ethnobotanical knowledge.

Keywords: Ethnobotany, medicinal plants, Philippines

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Assessment of Soil Microbial Activity Measurements to Distinguish Land Uses in Leyte, Philippines

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Since the 1940s most native forests in the Philippines have been replaced by shifting cultivation, perennial crops and bushland or pasture areas. For Leyte island, as an example, coconut plantations today account for roughly 23 % and grassland for 12 % of the total land area, while old growth and residual forests cover about 11 %. According to other sources, primary forests have been reduced to 10 % of their original area from the 1950s to 1990s (Asio 1996). During the last decades, different reforestation systems have been implemented in Leyte to halt this tendency. In contrast to state-promoted projects focusing on fast-growing exotic trees, the so-called reforestation system makes use of indigenous high-value timber species, mainly Dipterocarpaceae, planted in high density and diversity. The presented study aims at comparing soil characteristics of successful 'reforestation' farms installed in the early 1990s to such under adjacent bushland and pasture areas. Considering the similar land-use history of the paired plots before the 1990s, it is assumed, that more than ten years of reforestation have contributed to present differences in soil characteristics. Sampling sites include volcanic as well as limestone areas and were first classified according to WRB (ISSS-ISRIC-FAO, 1998). For assessment, paired plots were then analysed with respect to pH, Corg and NT, available cations and phosphorus. For sampling, special attention was paid to small-scale variability of the plots. In order to compare biological parameters such as basal respiration, substrate-induced respiration and phosphatase activity, experiments with samples from all plots were carried out under controlled conditions in the laboratory. Litter decomposition was assessed on some of the plots.

Keywords: Agroforestry, land-use change, reforestation, soil microbial activity

Ecosystem Approach for Landscape Rehabilitation — Review and Perspectives of the Rainforestation Farming Technology in the Philippines

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The Convention on Biological Diversity adopted the ecosystem approach for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable fashion.

An innovative ecosystem approach, combining the necessities of rural development, biodiversity conservation and rehabilitation and a sound resource management was developed on the island of Leyte in the Philippines. This approach, under the acronym of 'Rainforestation Farming' is based on the assumption that a farming system in the humid tropics is increasingly more sustainable the closer it is in its species composition to the original local rainforest.

This recommended subsistence farming technology includes indigenous forest and fruit trees, as well as shade-demanding crop plants like the fibre-banana (*Musa textilis* Nee).

First year sun-demanding pioneer trees are planted at close distances of 2×2 m to reach a closed canopy for shading out grasses, like *Imperata cylindrica*. In the second year hard wood-timber trees and fruit trees are planted in the shade of the pioneers. Seeds and seedlings come from mother trees in the remaining natural forests. Identification, protection and collection of the seeds and seedlings are part of the village-based community activities. Economically this technology is the best and most sustainable option, compared to systems like *Abaca* + coconuts or *Abaca* + *Acacia* sp. farms, a subsistence farmer on Leyte can adopt.

After already 4 years a forest with about 20–25 different rainforest and fruit tree species is usually established in the former *Imperata cylindrica* grassland.

The reforested close canopy subsistence farming area is also a newly created habitat even for such endangered species like the insectivorous nocturnal ape *Tarsius syrichta*, the herbivorous flying lemur, *Gynocephalus volans*, as well as numerous pollinators like bats, amphibians and insects.

Keywords: Biodiversity conservation, Leyte, Philippines, rainforestation, subsistence improvement

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Agricultural Research — On Ethics and Responsibility of Science for Poverty Reduction and Food and Nutrition Security

JOACHIM VON BRAUN

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This paper aims at assessing current and emerging ethical issues of agricultural sciences and proposes a set of actions on what to do in response to these issues.

As the world becomes more populated — approaching 9 billion in the next generation — and as the food chains become longer and more complex, ethical questions and the responsibilities of agricultural science becomes ever more important. That relates to domestic and international agricultural research, as much of the domestic research is also relevant internationally in the globally integrated agricultural science and market systems.

While food consumption is conditioned by hugely diverse habits and tastes around the world, and production is partly a function of agro-ecologies, again of huge diversity, the food system is largely driven by economics and hardly by an ethical value system. Increasingly however, the links of the food system to human health come to the forefront. When the food system is understood as part of or closely linked to the health system, the ethics of the medical profession may shape the future food systems' ethics. The related implications and potentials for “healthy” new ethics of food systems shall be explored here. While the adoption of ethical principles from the medical profession might go some ways toward shaping food and agriculture related ethics beyond the “do not harm” principles, it is also called for that the agriculture profession relates more to the broader ethics profession for defining relevant concepts, issues and coherent actions.

The largest ethical issue of food production, consumption and trade is the persistence of hunger. Under no ethical concept is hunger acceptable; comprehensive sets of policies and programs exist to address the problem, yet hunger does persist. What fresh approaches for strengthening ethical foundations and rights may facilitate change in science, in policy and — most importantly — in behaviour that contributes to reducing hunger?

A related ethical issue arises around the behaviour that determines the means of poor people's access to food. Production technology, property rights (including land and intellectual property rights), and access to markets are part of this. Implicit and explicit hindrances of production possibilities result from ethics of technology pessimism among those who could facilitate progress (biotechnology is one example), from over-regulated or ill-designed intellectual property rights (preventing fast access by poor nations), and from trade protection.

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Another ethical issue has to do with consumer's lack of trust in food safety. Use of pesticides on produce, genetically modified foods, and spillovers from animal diseases to humans, have made consumers apprehensive about the impacts of food on human health. Also, the ethical externalities of production processes, such as animal welfare and environmental concerns, have become more relevant to consumers, especially in high-income countries.

A growing issue is the perceived deepening of information asymmetries between producers and consumers. Since agricultural research is increasingly being conducted by scientists affiliated with private corporations, consumer groups are suspicious of research outcomes, which they feel are geared more towards profit maximisation rather than towards enhancing consumers' interests. Related is the concern about growing concentration in the food industry that may enable producers and retailers to transmit information selectively, thus infringing on consumers' sovereignty to make informed decisions with regards to food consumption.

Lastly, there are ethical issues arising from externalities of behaviour and from new ethics itself. For instance, consumer behaviours such as unhealthy diets can be carried over to the next generation; production and trade regulations founded in local ethically considerations may adversely impact others through price and income effects in that the enhanced moral wellbeing of some (rich) consumers may have negative repercussions on other (poor) producers and consumers. Thus, questions to reflect on here are:

- Incentives for ethics: What kind of incentives can induce behaviour change from stakeholders in order to address the issues mentioned above? Are such incentives "ethical"?
- Regulation for ethics: To what extent can ethical principles be used to establish institutions and organisations that uphold ethics in the food and agricultural sector? What is the role of regulations and restrictions for that?
- Activism for ethics: What kind of interventions can induce positive ethical activism and consumer strengthening on food ethics?
- Distribution of ethics: Whose ethics determine the shape of the food system? And how will ethical behaviour related to production, consumption and trade impact the poor?

Ultimately agricultural science, including "soft" and "hard" sciences, is to be science with a heart, serving people. So, what to do in practical terms? Areas of action highlighted in the paper are codes of conduct for the food industry and civil society organisations; establishing organisational mechanisms for discourses in ethics; incentives for behaviour change; ethics for business; the ethics of governance and rights for food security; and providing an ethical context to strengthen roles of marginal actors.

Related investments in ethics may have high social payoffs. A renewed engagement of agricultural science with ethics - including in curricula - might enhance empowerment, and political will that would facilitate the needed scaling up of science and its focus on for the purposes of ending hunger, improving food systems that serve people's well being, and enhance sustainable resource management. Ethical discourse suggests that the agricultural science systems in high income / high science countries, such as Germany, have a responsibility to serve these purposes, and must be expanded and strengthened for these roles for the long term.

ICIPE's 4h Paradigm: Approaches to Environmental, Plant, Animal and Human Health Research in Tropical Africa

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Many of Africa's problems are associated with a lack of energy for growth and development. Arthropods (insects, ticks and mites, spiders and others) - the most diverse and abundant forms of life on earth - are therefore recognised as a major contributor to the continent's lack of sustainable growth because of their ability to severely reduce the output of humans, animals and plants.

The International Centre of Insect Physiology and Ecology (ICIPE — www.icipe.org), was established in 1970 in direct response to the need for alternative and environmentally friendly pest and vector management strategies. Based in Nairobi, Kenya, ICIPE is mandated to conduct research and develop methods that are effective, selective, non-polluting, non-resistance inducing, and which are affordable to resource-limited rural and urban communities. ICIPE's mandate extends to the conservation and utilisation of the rich beneficial arthropod resources found in Africa and the tropics in general.

ICIPE focuses on sustainable development, to include human health as the basis for development and the environment as the basis for sustainability. Working in a holistic and integrated approach through the 4-Hs paradigm — Human, Animal, Plant and Environmental Health — ICIPE aims at improving the overall health of communities in tropical Africa by addressing the interlinked problems of poverty, low agricultural productivity, poor health and degradation of the environment.

ICIPE recognises that an increase in productivity cannot occur without a healthy workforce because sick people cannot be active in economic development. The Centre's Human Health Division (HDD) therefore focuses on improving the health of people so that they can be more active in the economy. The HDD is at the forefront of the control of one of Africa's most costly diseases — malaria. ICIPE is contributing to an integrated vector management approach (IVM) for malaria-carrying mosquitos by developing environmentally friendly tools and strategies to control the vectors at all life-stages, including the use of botanicals like Neem and bio-pesticides like Bt, to break the cycle of transmission.

New and novel approaches for controlling the riverine tsetse group, vectors of human sleeping sickness, an important re-emerging disease in tropical Africa, which has been recognised by the WHO as a Global Challenge, are also being developed to improve human health.

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Similarly, livestock diseases continue to hold back development in large parts of Africa. In addition to being the source of milk and meat for pastoralists, animals provide farmers with draft power, hides and social status and wealth. ICIPE supports this prime role of animals by developing and promoting appropriate technologies for the sustainable management of tsetse and tick disease vectors within sustainable farming systems in order to improve animal health and productivity.

ICIPE is contributing to improved sustainable food security and environmental health through the development of integrated pest management systems (IPM) in agricultural and horticultural crops, like biological control, use of behaviour modification, cultural methods and arthropod-active botanicals, with an emphasis on control approaches with no detrimental impact on the environment.

Environmental sustainability, a prerequisite to social and economic development, is a concept that ICIPE has wholly embraced since its founding 35 years ago. One of the Centre's main arenas of operation is developing integrated management methods that eschew the use of pesticides and maintain biodiversity.

In tropical Africa, the main roadblock to environmental conservation is poverty. Farmers too poor to rejuvenate the soil with nutrients or allow a fallow period, and forced to over-harvest forests and natural vegetation for income, are over-stretching demands on the environment and consequently disrupt nature's regenerative potential. Removing people's reliance on the forest by engaging them in commercially viable projects, such as sericulture and apiculture and cultivation of medicinal plants, is one of ICIPE's latest ventures.

As the only international institute working primarily on arthropods, ICIPE recognises its advantage in addressing the complex cross-cutting challenges affecting the continent. It further realises that the development of tropical Africa cannot be achieved without the advances in technology, such as the ones listed above, being adopted by the target communities. ICIPE's Centre-wide goals, therefore, include capacity building of individual researchers and institutions in the tropics; empowering women and harnessing the youth and building capacity to use, transfer and teach its technologies. In this way, ICIPE hopes to continue to work 'in Africa, for Africa' — the continent with the greatest needs.

Agroecologically sound Agricultural Systems: Can They Provide for the World's Growing Populations?

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Global food prospects, especially for the tropical regions, are not necessarily optimistic for this new century, despite various current technological advances. Population growth is slowing down, but overall growth will continue at least through the middle of this century. Land and water available per capita for agricultural production will invariably keep declining. To feed the growing populations, the productivity of all factors will need to increase considerably. Unfortunately, future progress with 'modern agriculture' — relying particularly on genetic improvements and increased inputs of exogenous, purchased inputs — is becoming problematic. There has been little improvement in global cereal production over the past decade, while per capita world production of cereals has been stagnant and even declining since the mid-1980s.

What is referred to as 'modern agriculture' is facing many challenges: **(a)** Costs of production are increasing, and market competition has farmers in a price squeeze; **(b)** Government subsidies that have sustained agricultural producers in the U.S., Europe and Japan are contracting, so heavy input-dependence needs to be reconsidered; **(c)** Relying on inputs derived from petroleum — many fertilisers, insecticides, fungicides, etc. — is becoming more uncertain and more costly; **(d)** Adverse environmental impacts from the application of agrochemical inputs are cumulating, with increasing government regulation of their use; **(e)** Global climate change will force reorientations of agricultural production strategies, as global warming will be less of a challenge than greater variability of climate (extreme events). Modes of production that could be successful in the preceding century are becoming less likely to succeed in this one. Already there is a dropoff in the expansion of chemical fertiliser and agrochemical use worldwide.

Biotechnology offers some prospects for dealing with various constraints and creating new opportunities. But its timeframe for creating the expected benefits is uncertain, while the costs of biotech development are very considerable, and regulatory issues associated with biotech present many difficulties, most still unresolved. Further, the use of biotech remains controversial due to varying assessments of environmental risks and hazards.

Agroecology is already available, not something on the horizon — even though it has received only a tiny fraction of the research resources that have been made

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available for biotech. The costs of developing and extending agroecological practices are much less than those for biotechnology, and regulatory issues are minimal. As seen from the case of the System of Rice Intensification (SRI), agroecological methods can match or outperform the results of biotechnology, making them more cost-effective. Agroecology offers a paradigm for 'post-modern agriculture' in that it represents a next step beyond current agricultural theory and practice. It differs from 'post-modernism' in the humanities and social scientists in that it is not hostile either to 'modernity' or to science. It builds upon the most modern science in the contemporary biological and ecological domains, capitalizing particularly on what is becoming known in the realms of soil biology and soil ecology.

The 'Green Revolution' as the apotheosis of modern agriculture was premised on two main strategies: **(a)** Changing the genetic potentials of plants and animals, and **(b)** Increasing the use of external inputs — water, fertiliser, insecticides, etc. Agroecology does little or none of either, minimising the use of exogenous inputs. It prefers to mobilise the endogenous capabilities of a cropping system and its relevant environment by optimising the management of plants, soil, water and nutrients, to have a beneficial effect on soil biota. In the $G \times E$ interaction (genetic potential \times environment) that determines the phenotypical development of each and every organism, it works on the 'E,' to make the most of any 'G.'

Agroecological management aims in particular to: **(a)** Promote the growth and functioning of root systems, which are the interface between plants and their soil environment, and **(b)** Increase the abundance, diversity and activity of soil organisms, which provide many benefits and services to plants. Having well-developed root systems and active soil biota can reduce water requirements and the costs of production, among other benefits.

The System of Rice Intensification (SRI) is discussed at some length because it represents an agroecological strategy that enhances food production and contributes to food security while at the same time improving the natural resource base on which agriculture and other human activities, as well as life itself, depend. It was developed 20 years ago in Madagascar by FR. HENRI DE LAULANIÉ, SJ. His synthesis of innovative, mostly counterintuitive practices that constitute SRI followed 20 years of working with farmers, making observations and doing experiments, plus some serendipity. SRI benefits have now been seen in at least 22 countries.

The basic practices are **(1)** Start with young seedlings, transplanted when they are <15 days old, grown in an unflooded, garden-like nursery; **(2)** Plant seedlings singly, rather than in clumps, widely spaced in a square pattern, and very carefully to avoid trauma to the roots; **(3)** Apply reduced water, just the minimum needed by the plant, keeping the soil mostly aerobic; **(4)** To control weeds, farmers are advised to weed with a 'rotating hoe', which aerates the soil at the same time that it churns weeds into the soil to decompose; and **(5)** Provide as much organic matter as possible, for the soil organisms as well as the plant.

SRI has been producing some remarkable results: **(1)** Immediate benefits from these practices, with no period of ‘transition’ as is common with many conversions to ‘organic agriculture’; **(2)** Yield increases of usually 50–100 %, and often more, without changing rice varieties; **(3)** No need for mineral fertilisers, since compost gives better yields; **(4)** Little or no need for agrochemicals, since SRI plants are more resistant to damage by pests and diseases; **(5)** Less water required, usually 25–50 % less, and also seed saving as this need is reduced by 80–90 % due to the dramatic cut back in plant population; **(6)** While more labour is required initially — the main limitation on SRI adoption, along with the need for reliable water control to get best results — SRI can even become labor-saving once farmers have mastered its methods.

This all sounds ‘too good to be true’, and it has come under some attack in the agronomic literature in recent years. However, SRI should be put to empirical tests, rather than being dismissed or ignored on grounds of logic, preconceptions or prejudice. An evaluation of SRI in Cambodia, commissioned by GTZ and reported by Anthofer at the Tropentag 2004, confirmed what had been learned about SRI and reported from other countries.

General benefits resulting from SRI include: **(1)** Accessibility by the poor, since SRI has minimal capital costs; **(2)** Greater profitability, with costs of production averaging 20 % less; **(3)** Reduction in economic risk, documented in evaluations done in Cambodia and Sri Lanka for GTZ and IWMI; **(4)** Environmental benefits from the reduction in water requirements and from reduced use of agrochemicals; **(5)** Human resource development due to its strategy for dissemination which emphasises farmer experimentation and encourages farmer innovation in ways that conventional agricultural technology development does not.

In specific agronomic terms, SRI farmers report the following advantages accompanying higher yield and profitability: **(1)** Drought resistance; **(2)** Resistance to lodging; **(3)** Reduced time to maturity; **(4)** Resistance to pests and diseases (which can probably be explained by the theory of trophobiosis proposed by Francis Chaboussou in 2004); **(5)** Conservation of rice biodiversity. Perhaps the most interesting development with SRI is the extrapolations that farmers have been making of its concepts and methods to other crops besides irrigated rice, e.g., upland (rainfed) rice in the Philippines; finger millet (ragi) and sugar cane in India; winter wheat in Poland; and even chicken production in Cambodia (explained in the presentation and paper).

With SRI methods, farmers have seen that ‘less can produce more’ if biological processes are understood and capitalized upon: **(1)** Smaller, younger rice seedlings become larger, more productive mature plants when combined with other SRI practices; **(2)** Fewer rice plants per hill and per m² give higher yield when used with other SRI practices; **(3)** Half as much water can produce more rice because aerobic soil conditions are more supportive of root health and plant growth than are anaerobic (hypoxic) conditions; and **(4)** Greater output is possible with fewer or no chemical inputs because these increase plants’ susceptibility to pests and diseases.

There are sound, scientifically-respectable explanations for the performance of SRI. There is nothing magical, mysterious or miraculous about it. However, most of the factors explaining SRI productivity are at present still hypotheses, derived from well-established knowledge in the agronomic and microbiological literature, but not yet proven. Only a few scientists have become engaged with the research issues and opportunities that SRI raises; but this work has begun.

There are many ways in which biological processes could be contributing to the SRI results reported above. Not all of them need to be operative to construct an adequate accounting for the overall effects of SRI practices. SRI is still a rather 'young' innovation. Because its methods fit into a larger body of theory and practice known as agroecology, most of its proponents are concerned with how to make the agricultural sector as a whole more productive and sustainable.

The challenge is to learn how to capitalize upon the possibilities that SRI has demonstrated: that 'more' can be produced from 'less' by capitalizing upon existing biological potentials and processes. This does not mean that research and experimentation on other methods should not proceed; there are some problems that may best be solved with genetic modifications, by conventional or other means. But certainly more attention and investment are due to agroecological approaches than they now receive if world food needs are to be met in the future.

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Reducing Raw Bovine Milk Spoilage through the Lactoperoxidase System in the Western Highlands of Cameroon

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The development of the Cameroonian dairy production got stuck, as milk production is concentrated in regions that are often far from consumers and processing plants. Large quantities of milk are lost through spoilage and poor collection systems. Moreover, refrigeration facilities are widely absent in rural dairy farms. The use of chemical methods for milk preservation such as the lactoperoxidase system (LPS) might offer a solution.

We studied the effects of the LPS on raw bovine milk in three villages in the Western Highlands of Cameroon during the rainy season. Milk collection was done 10 times, using bulk milk from 14–32 farmers. The LPS was activated by addition of 10 ppm thiocyanate and 8.5 ppm peroxide to milk, followed by thorough mixing. Part of the milk was left untreated (control). Treated and control samples were kept under three storage conditions: ambient temperature, water bath and refrigeration. Samples were monitored for spoilage at hourly intervals, except for those in the refrigerator, which were monitored six hourly. Microbial population was also estimated at intervals, using the standard plate count method.

The average increase in shelf life of treated milk with respect to the control milk was +7.1 (SD 2.4) hours under ambient temperatures, +8.1 (SD 3.0) hours in a water bath and +46.2 (SD 21.2) hours in the refrigerator. The LPS reduced microbial counts (cfu ml⁻¹) from 5.24×10^6 to 1.47×10^6 after 3 hours and from 5.12×10^8 to 3.36×10^7 after 8 hours under ambient temperatures.

We concluded that treatment could enable the farmer sell his milk in far-off markets. Also, treated evening milk could remain in good condition for the next day's use without refrigeration. Enabling storage of milk allows the farmer to increase milk quantity by milking twice a day instead of once while not changing the transport frequency. Dosage of LPS in the field is easy, as FAO provides small-prepared quantities of the activator. Treatment alone will not be enough to develop the dairy production, but should go along with adequate improvements in cattle management.

Keywords: Cameroon, lactoperoxidase system, raw milk, spoilage

Mortality Constrains Production Efficiency in Smallholder Local Chicken Production in Jordan

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The production system of local 'Balady' type chicken was characterised under village management conditions in 18 villages in northern Jordan. Data were collected from 120 randomly selected households by using participatory rural appraisal (PRA) approach and applying structured questionnaires. Identification of diseases is based on information provided by farmers describing symptoms and validated by using photographs and veterinary advice. This study aimed to identify the causes of chicken mortality as a major constraint reducing the efficiency of production.

Local chicken play an important role as a source of high quality protein for poor rural people. Primary functions of local chicken were egg production for home consumption (65 % of households), followed by generating cash income (35 %). Thirty-five percent of households reported that 40 % of the flock was lost before reaching 6 months of age. Broadly speaking, mortality from diseases, predators, parasites, and cold stress for chicks accounted for 49 %, 31.6 %, 10 %, and 9.4 % of the total loss, respectively. The most frequent outbreak of diseases, as perceived by the surveyed households, was in the order of occurrence: Newcastle Disease (51 %), Infectious Bronchitis (21 %), Fowl Typhoid (18 %) and other diseases (10 %). The main predators were foxes (25 % of the cases), and wild cats (11.5 %). In addition, young chicks were predated by cats (25.5 %) and rats (14 %). In terms of health care, 15 % of households treated their birds when they fell sick, and 12 % used vaccines. However, the use of ethno-veterinary medicine was more popular and applied by 28 % of the households. Average flock size per household was 41.6 (SD 32). The mean annual financial loss per flock due to mortality was estimated at Jordan Dollars 32 (SD 28; 1 JD=1.4US\$).

In conclusion, Balady type chicken contributed significantly to the nutritional and economic functions in rural communities. However, mortality due to diseases and predation constrain drastically these functions. National programs must take place to control diseases by improving animal health care and vaccination, particularly for Newcastle disease. Introduction of adequate housing and fencing would protect the birds against predation.

Keywords: Balady chicken, Jordan, mortality, poultry diseases, predators

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Characterisation of the Smallholders Livestock Production Systems of the South Region of Río Negro, Patagonia, Argentina

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Aiming to identify key factors for rural development in the South Region of Río Negro, Patagonia, Argentina, smallholder livestock production systems affected by the international wool price crisis were characterised: sheep (S), sheep-goat (SG), sheep-cattle (SC) and sheep-goat-cattle (SGC), kept in three ecological areas: Monte (M), Central Plateau (CP) and Hills and Plateaus (HP). Households were significantly larger ($p < 0.05$) in SG, SC and SGC (3.5) than in S (1.7). Educational levels and demographics were similar between systems ($p > 0.05$). Household heads were on average 52 years old and 18 % were illiterate, 69 % attended elementary school and 14 % attended secondary school. Sheep were dominant in all systems, with an average number per flock of 452 (SD 391) without significant differences among systems ($p > 0.05$). Goat flock and cattle herd sizes were 160 (SD 134) and 30 (SD 32), respectively. Horses were present in all systems with an average herd size of 18 (SD 12). Fenced perimeter was 82 % on average, with a mean of 1.6 paddocks per farm. Farms located in the ecological area M kept significantly more sheep, goats, cattle and horses than in CP and HP ($p < 0.05$). Consequently, the number of Sheep Livestock Units (SLU) in farms located in M (660) was around 40 % higher than the number of SLU in farms located in CP (375) and HP (360). Farms in M (4192 ha) were significantly bigger ($p < 0.05$) than farms located in HP (2156 ha) and CP (2155 ha), but stocking rate among the ecological areas was similar ($3.8 \text{ ha}^{\text{ha}}/\text{SLU}$) ($p > 0.05$). Farms in M fenced almost all the perimeter (98 %), significantly more ($p < 0.05$) than the farms located in CP (79 %) and HP (72 %). The average number of fenced paddocks was not significant different across ecological areas. Summarising, farmers have low literacy, in diversified systems households are larger and sheep are still important in diversified systems; and farms located in the ecological area M are more resource endowed. Therefore, promotion of diversification and improvement of productivity, particularly in farms located in CP and HP, should be the priority for development.

Keywords: Diversification, ecological areas, Patagonia, sheep farms, smallholders systems

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Pre Birdflu Production System of Vietnamese H'mong Chicken

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H'mong chicken can be found in the mountainous areas of Northern Viet Nam. The meat is traditionally known as the most tasty one among local and commercially produced chicken. This paper presents phenotypic characteristics and the production system based on data just before the birdflu epidemic broke out.

Agricultural production is based on shifting cultivation, the use of the hand hoe and husbandry of local breeds of buffalo, pigs and chicken. In the study area Mai-son District, Son La Province, Northern Viet Nam the human population was about 115 000 people and the chicken population estimate was 360 000 birds. Fifty-five households (8 % of total households) in three villages were surveyed using structured questionnaires between November 2003 to March 2004. In total 794 chicken were phenotypically described.

Flock sizes averaged 14.4 chicken per household. The sex ratio was one cock to only 1.5 hens. The flock structure indicated high chick mortality. 70 % of the chickens had brown feather colour including multicolour. Yellow skin colour dominated with a frequency of 94.7 %; 95.6 % and 96.9 % of chickens had black legs and beaks, respectively. Body weight of adult chicken was 1617 g (SE 52) on average. Hatchability was above 80 %, mean egg number per clutch 12 to 13 and egg weight 41 g. The majority of the households (85 %) provided chicken housing. All farmers supplemented whole maize twice per day, which could not be quantified. Chicken production was mainly for home consumption and rarely products were marketed despite the fact that pre-epidemic market prices for H'mong chicken were about one third higher than prices for commercial broilers in the urban market of Hanoi.

In conclusion, H'mong chicken are characterised by high variability in feather colour and performance but appear to be one population. The traditional system avoids inbreeding and input-output levels are apparently well balanced making the system sustainable. The pre-birdflu marketing potential was not realised by the local chicken keepers.

Keywords: Birdflu, H'mong chicken, Northern Viet Nam, phenotypic characterisation, subsistence production system

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Genetic Reduction in Feather Coverage Minimizes Performance Losses of Broilers Reared under Hot Temperature

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Broiler production under hot temperatures suffers from the inadequacy of contemporary fast-growing stocks which are bred for high rate of feed intake and metabolism under temperate conditions. Brought to hot temperature regions, they exhibit decreased livability and do not reach their genetic potential for broiler performance. This happens because under high ambient temperatures, dissipation of excessive internal heat — outcome of high metabolic rate — is hindered by the feathers. Therefore it was hypothesised that heat stress can be alleviated by the use of the major genes Naked Neck (Na) and Scaleless (sc) that, respectively, reduce or eliminate feather coverage.

A controlled trial at Rehovot (Israel) included four genetic groups (normally feathered, heterozygous naked-neck, homozygous naked-neck, scaleless), progeny of the same double-heterozygous parents (Na/na Sc+/sc), and a commercial line as industry reference. The 331 birds from all groups were brooded together, and on day 21 each group was separated to two sub-groups. Birds from one sub-group from each group were reared together under normal ambient temperature (constant 25°C), and all the remaining birds were reared together under high ambient temperature (constant 35°C). Live weight and body temperature were recorded repeatedly from hatch to slaughter, at about 50 days, when carcass yields were recorded.

Mortalities throughout the experiment were higher in the commercial and normally-feathered groups than in the reduced-feathered groups. The featherless (scaleless) birds exclusively showed similar live weights at slaughter under the two temperatures, while the commercial line had the highest and earliest depression in weight gains under hot temperature as compared to normal temperature. Breast meat yields of the featherless birds were the highest of all groups under both temperatures. The heterozygous and homozygous naked neck birds had also higher relative meat yields compared to the commercial and the normally-feathered broilers in both temperatures.

The experimental birds carrying the major genes have not been selected yet up to the level of contemporary commercial broiler lines. Further selection for rapid growth within these experimental lines, or the introduction of the major genes into already selected commercial lines, are promising approaches to improve production of broiler meat in hot conditions.

Keywords: Breast meat yield, broiler, featherless, genetically-reduced feathering, hot climates, livability, Na gene, naked-neck, sc gene

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Prosperity at a Price? Balancing Opportunities from Cash Crops with Risks of Animal Disease and Drug Resistance

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The largely successful innovation of cotton production using draft cattle is driving change in traditional subsistence farming in West Africa. But the new opportunities from integrating with global markets may perversely increase risks of cattle disease and drug resistance. In the cotton zone, where trypanosomosis is the most important cattle disease, a project funded by BMZ (Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung, Germany) carried out socio-economic and epidemiological studies to investigate how disease dynamics are changing in response to changing farming systems. A Knowledge, Attitude and Practice study covered farmers (n=891) in south-western Burkina Faso (established commercially-oriented farming), South Mali (expanding commercially-oriented systems) and in Guinea (traditional systems still predominate). A strong gradient was revealed; commercial farming areas in the east had reduced indigenous trypano-tolerant cattle (down to 19.5%), high levels of sickness and death (22% annual morbidity and 34% case fatality) and high expenditure on trypanocide drugs (\$12 per household), while the traditional systems in the west had retained indigenous breeds (98%), showed less morbidity (22%), much less mortality (5% case fatality) and low expenditure on trypanocides (\$3.2 per household), with areas in between the two locations showing intermediate values. Epidemiological surveys in the same villages (n=77 villages, 5,429 cattle) showed a similar gradient of trypanosomosis prevalence (decreasing from 13.4% in Burkina Faso to 3% in Guinea). Studies that tested for drug resistance, which were carried out in a subset of 20 villages, revealed an analogous pattern of occurrence of drug resistance (decreasing from 100% in Burkina Faso to 0% in Guinea). A mathematical model (SEIR) was developed which showed how farming system, market-connectedness, cattle breed and drug inputs could influence disease prevalence and drug resistance. The model predicted that as commercially oriented farming practices extend, the problems of disease and drug resistance experienced today in Burkina and West Mali will spread to East Mali and Guinea. Project efforts are described that are oriented towards training and informing farmers, service providers and policy makers. These activities help to mitigate unanticipated and unwanted effects of market integration without jeopardising its benefits.

Keywords: Drug resistance, SEIR mathematical model, trypanosomosis, West Africa

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Equipping Farmers to Seek Animal Health Care in a Changing Market

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African agriculture remains heavily dependent on livestock and severely constrained by livestock disease. In the newly liberalised and privatised economies, managing non-notifiable veterinary diseases is now largely the responsibility of the individual farmer. However auto-medication can result in incorrect treatments causing economic loss, drug resistance and negative impacts on human health. A BMZ-funded project working in Burkina Faso, where trypanosomiasis is the most important cattle disease, has the objective of better managing trypanocide resistance. To investigate farmer behaviour that could lead to drug resistance, Participatory Rural Appraisals (260 participants) and questionnaire surveys (348 respondents) were carried out. These showed that drug use in the community by non-professionals was widespread (80.1%), as were misconceptions on drug use (43%) and overuse of drugs due to poor diagnosis (64% of farmers ignorant of specific signs). Under-dosage is a particular cause for concern, as this is a major factor in development of drug resistance: we found 10% of cattle received under-dosage of diminazene drugs and 21% under-dosage of isometamidium (ISMM) drugs. At the same time alternatives to drug use (i.e. control of the insect which transmits trypanosomiasis and use of trypano-tolerant breeds) were little known and less practised. Only 53.2% of farmers were aware of insect control and none practised it, while trypano-tolerant animals have been largely replaced by exotic cattle and their crosses (95.6% of farmers keeping these). A further survey on farmers' needs and sources for information (n=100), showed that training, extension leaflets and sellers of drugs are the most-preferred sources (together comprising 80.9% of first preferences). To develop information packages, choice tests were carried out to find farmers' preferred type of illustration, font and type size and farmer understanding of symbols, dates and abbreviation. Combining findings on information needs and preferred channel /format of information, we produced exemplars of informational material for farmers. Firstly a picture book covering cattle diseases, drug use, vector control, and nutrition in local language, secondly an extension leaflet on Rational Trypanocide Use and thirdly a series of posters/calendars on drug use and promotion of trypano-tolerant breeds. Testing showed these were comprehensible and effective in increasing farmer knowledge.

Keywords: Drug resistance, extension, rational drug use, Trypanosomiasis

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Present Situation of Porcine *Hernia inguinalis* / *scrotalis* in Thailand

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Hernia inguinalis/scrotalis is one of the most important congenital anomalies in pigs. The phenotype is believed to result from a weakness of the musculature surrounding the inguinal canal, permitting the intestine to drop into the scrotum (*Hernia scrotalis*) or into the inguinal canal (*Hernia inguinalis*). Estimated heritability for the disease range from 0.2 to 0.6 in different breeds and populations. Several candidate genes have been suggested to be causative for the disorder along with maternal and environmental influences. The Förderverein Biotechnologieforschung der Deutschen Schweineproduktion (FBF) reported a frequency of herniated pigs with about 2 % in Germany causing losses in a range of about 2 million € per year. In Thailand, we recently began to survey frequency data in 4 industrial pig farms (> 5,000 heads), 5 middle-sized farms (500–5,000 heads) and 10 small-sized farms (50–500 heads). The frequencies of herniated animals ranged from 1 % (industrial pig farms) to 5 % in small-sized farms. The economic loss per herniated pig is about 300 baht (discount per animal for slaughter), alternatively the costs for castration are 150 baht per head. Taking the total number of pigs in Thailand (about 6,3 million pigs; Department of Livestock Development, 2004) the defect causes an annual loss of 19–95 million baht (0,38–1,9 million €). These data show that *Hernia inguinalis/scrotalis* is an economical problem for Thai pig breeders. We further intend to analyse genetic parameters and to identify environmental factors affecting the disease. We will genotype several candidate genes such as INSL3 in herniated and phenotypically unaffected animals. The application of both quantitative and qualitative analyses will be helpful to solve this congenital disorder in pigs.

Keywords: Disease, economic loss, hernia, swine

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Selection Responses from Optimised Breeding Objectives for East-African Pastoralists Including Trypano-Tolerance

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A major disease constraint on livestock productivity in Eastern Africa is trypanosomosis which directly affects the livelihood of poor livestock keepers. The objective of this study was to design a breeding goal including trypanosomosis to increase trypano-tolerance in cattle in pastoral, agro-pastoral and crop-livestock systems of selected sites in Kenya and Ethiopia. Based on the results from socio-economic surveys in the field (Narok district, Kenya), a breeding goal was designed for pastoralists which contained the most important traits in African cattle: milk yield (MY), calving interval (CI), weight gain (WG), trypano-tolerance and tick-resistance. Two selection indexes were constructed one with and the other without packed red blood cell volume (PCV) as a measurement of tolerance for the disease in the breeding program. The baseline selection index I (SI-I) contains traits that directly influence livelihood and income: MY, live weight and CI compared to selection index II (SI-II) that included PCV in addition to traits in SI-I.

According to the findings in the field the following population structure for pastoralists was assumed in this study: Number of cows is 200 over 10 age-groups with a replacement of 20 cows each year. The mating ratio of sires is 1:10 with 2 sires for each age-group. With a survival rate of 80 %, 160 offspring are produced per year.

With SI-II, an increase in MY and WG of 6.8 % (2.25 kg) and 5.0 % (2.01 kg) of the phenotypic standard deviation (SDP) per generation was estimated. This is 2.2 % less MY (0.05 kg) than with SI-I but 0.5 % more WG (0.01 kg). The CI increases with 0.5 % (0.5 days) of the SDP per generation for SI-II, 31.3 % (0.15 days) less compared to the results of SI-I. The trypano-tolerance and tick-resistance level increases by 3.7 % (0.13 less treatments) and 2.3 % (0.07 less treatments) of the SDP per generation with SI-II which is 11.8 % (0.057 treatments) and 1.3 % (0.001 treatments) better for trypano-tolerance and tick-resistance compared to the estimates of SI-I.

The results indicate a superiority of SI-II over SI-I, supporting the theory to use PCV as indirect selection criterion to improve disease resistance.

Keywords: Breeding objective, selection index, trypano-tolerance

Securing Pastoral Livelihoods through Support for Sheep Production in Rajasthan, India

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Sheep breeding is the traditional livelihood strategy of ten thousands of pastoralists inhabiting the drought-prone state of Rajasthan in Western India. Until the mid 1990s, sheep husbandry represented a fairly attractive economic option, generating income from wool, mutton, and dung. In recent years the situation has changed to the worse, mostly due to macro-economic developments, such as a global oversupply of wool that is depressing prices, and a series of droughts undermining demand for dung. A three-year project that conforms to the criteria of “People-Centred Livestock Development” (PCLD) was initiated in 2003, with the goal of improving economic returns from sheep breeding and thereby maintaining it as a viable livelihood option for Raika pastoralists. In a participatory process, four aspects of the sheep husbandry system were identified for possible interventions: disease control, breeding, marketing, and access to grazing and feed resources. Two years into the project, the following conclusions can be drawn: with respect to breeding and local marketing, the sheep breeders have already arrived at optimal solutions, and it is difficult to conceive any improvements. Disease control and access to grazing have emerged as the sectors where the project sees a potential for removing the systemic constraints. Improved disease control is approached by offering vaccinations against sheep pox, FMD, and other diseases, as well as teaching herd owners how to distinguish between genuine and fake medicines available on the market. The grazing problems are more difficult, but even more crucial, to tackle: sheep breeders have resolved to take legal action in order to regain their ancestral grazing rights that have been impinged upon by a wildlife sanctuary. The project results support the conclusions of a study produced by the FAO’s Pro-Poor Livestock Policy Facility that renders the organisational strengthening of livestock keepers and of building strong associations as most promising and crucial strategy for improving the livelihoods of marginal livestock keepers. This inference has several noteworthy implications for the orientation of livestock research that claims to help marginalised people.

Keywords: Disease control, grazing rights, India, livestock keepers’ associations, pastoralists, Endogenous livestock development, Rajasthan, sheep

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Development Perspectives of an Ukrainian Pig Breeding Farm from a Breeding and an Economic Point of View

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Pig production and supply of the Ukrainian people with pig meat still is far from being satisfactory. To improve the situation a focus has also to be given to quality aspects of meat.

The price system for trading pigs in Ukraine is classified according to three categories. Almost all pigs produced belong to the second category. A quality improvement of the produced pig meat is well paid. Purchasers are willing to pay 20 % more for pigs of the first category which is characterised by a back bacon density of 15 up to 20 mm and a weight of fresh slaughtered and not cooled pig body between 53 and 72 kg. This article analyses the possibilities for reaching this aim by different investments to improve the production facilities.

Data in form of intensive interviews, food analyses and participating observation were collected. For the analyses gross margin calculations, multi period investment methods and liquidity analyses were used. The case study was conducted in one of the leading piglet production farms in Ukraine in the area of Dnjepropetrovsk. The farm owns about 6,400 ha, 20,000 pigs, 1,200 sows and cattle. On the basis of an intensive analysis of the present situation the optimisation possibilities were defined and researched. There would be three different development paths based on the concept of an introduction of hybrid piglet production by purchase and import of Pietrain:

Variant a) breeding of Pietrain boars by purchase of Pietrain sows and artificial insemination by also purchased Pietrain sperm; b) suppression crossing by purchase of the Pietrain sperm and artificial insemination of sows of the Ukrainian meat race; c) purchase of young Pietrain boars. The results indicate that all three measures increase profitability. While suppression crossing shows the highest gross margin and entrepreneur profit, variant a) shows the highest annual interest rate for used capital and variant c) the shortest time needed to reach the objective. Depending to the overall situation, the choice between the variants may be different. Regarding the high insecurity for the coming political and economic development, it may be more interesting to forego on higher unsure rate of interest but to have a more save even if lower income.

Keywords: Economic assessment, pig breeding, crossbreeding, Ukraine

Pig Production in Georgian Republic - Situation and Improvement Concept

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Pig production was an important and flourishing sector of the Georgian economy up to 1990. With the break down of the plan economy the production of pigs became unprofitable. State breeding stations are no longer working. Price increase of means of production was much higher than meat price increase. Additionally missing management know-how and modern improved production procedures led to non-profitability. The annual consumption of pig meat declined from 1989 from about 15–20 kg per head to 9 kg per head in 2003.

This paper examines possibilities to improve the profitability of pig meat production in Georgian Republic.

Data were collected in September to October 2004 in 47 pig production farms by using standardised questionnaires. Most of the farms were identified by random sampling. The questionnaires dealt with farm size, number of animals per farm, feeding system, animal husbandry forms and losses, production procedures, labour demand, labour capacity and variable machine costs. For the calculations the prices of the year 2004 were used. Additionally pig feed was analysed.

The results showed that the Georgian farms can be grouped into small subsistence oriented family farms, mid size farms with piglet production and fattening for subsistence and market and big farms with market production. The gross margins per fattening pig differ between 90 € for big farms and 41 € for small subsistence oriented family farms. The same ratio can be found for the piglet production with 115 € gross margin for big farms up to 51 € gross margin for small subsistence oriented family farms.

To increase the economic situation the impacts of improved piglet production was examined. Therefore the impact of improved feed, selection, local races, more information and state measures of development of production and marketing are discussed.

Keywords: Economic assessment, Georgian Republic, pig breeding

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Use of Fresh and Dry Guava Leaves as Supplement in Weaned Pig Diets

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Psidium guajava Linn. (guava) leaves were ground and used as supplement in weaned piglet diets to prevent post-weaning diarrhoea and reduce impaired growth performance. This experiment was conducted at Chiang Mai University, Thailand. Thirty weaned pigs (21 days old) were randomly divided into five groups of six animals each. Each pig was housed in an individual pen. Each group was allocated to one of the dietary treatments, which were formulated to meet NRC (1998) standards. Diet 1 control basal diet, Diet 2 and 3 basal diet with dry guava leaves at 2.5 and 5 g kg⁻¹, respectively, Diet 4 and 5 basal diet with fresh guava leaves at 7.5 and 15 g kg⁻¹, respectively. The design was completely randomised. The growth performance and faecal characteristics were determined for 35 days. Average daily gain (ADG), and feed conversion ratio (FCR) of pigs fed the diets 1 to 5 were: 270, 250, 310, 280, 300 g d⁻¹ and 1.92, 2.31, 1.80, 2.35, 2.16, respectively. Average daily feed intake (ADFI) were 520, 570, 550, 650 and 640 g d⁻¹. There were no significant ($p > 0.05$) differences in ADG and FCR amongst the treatments. However, the pigs fed the diet with dry and with fresh guava leaves 5 and 15 g kg⁻¹ of diet, respectively tended to have the highest ADG. The pigs fed diet supplemented with fresh guava leaves at 7.5 and 15 g kg⁻¹ of diet had significantly higher ADFI than the control. The faeces of the pigs fed diets with guava leaves at 15 g kg⁻¹ of diet had significantly ($p < 0.05$) better shape than those of pigs fed the fresh control diets but there were no significant ($p > 0.05$) differences to the pigs fed the diet with guava leaves 5 (dry) and 7.5 (fresh) g kg⁻¹ of diet. The incidences of diarrhoea in the pigs within each treatment group (as percentages) were: 33.3, 25.0, 16.7, 16.7 and 8.3 for diets 1 to 5, respectively. It is concluded that the application of dry and fresh guava leaves at 5 and 15 g kg⁻¹ of diet, respectively, as feed additive has potential in feeding weaned pigs.

Keywords: Feed additive, guava leaves, weaned pigs, Thailand

Effects of Mixtures of Tropical Legumes with Contrasting Tannin Contents as Supplements to Low-Quality Grass Diets on Ruminal Fermentation *in Vitro*

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The use of legume trees and shrubs could be a useful means to overcome protein deficiencies prevalent in tropical ruminant production systems. However, many of the tropical legume species are rich in tannins limiting their utilisation by livestock. It has been postulated that the combination of these legumes with tannin-free legumes could contribute to an improved animal nutrition while contributing to plant diversity at the farm level. Two *in vitro* experiments were carried out with the gas transducer technique to evaluate the effects on ruminal fermentation of mixtures of legumes with contrasting tannin contents as supplements to the tropical grass *Brachiaria humidicola*. Both experiments showed that *B. humidicola* had a high potential *in vitro* dry matter degradability (IVDMD; >65 %) but the extremely low crude protein content (<5 %) prevents its use as a good source of fermentable energy, unless it is adequately supplemented with a source of degradable protein. The tannin-free herbaceous legume *Vigna unguiculata* improved protein supply without negatively affecting IVDMD. Supplementation with the tannin-free *Cratylia argentea* (CIAT 18516) resulted in similar or even slightly better fermentation characteristics of the complete diet than supplementation with *V. unguiculata*. Supplementation with the tanniniferous *Calliandra calothyrsus* (CIAT 22310) or *Flemingia macrophylla* (CIAT 17403) did not increase the amount of degraded protein but significantly suppressed IVDMD compared to the grass-alone diet. However, when supplemented in a mixture with *V. unguiculata*, *C. calothyrsus* or *F. macrophylla* could be included in the diet by up to 10 % without negative effects on fermentation. For *L. leucocephala*, which also contains tannins, this maximal proportion was around 20 %. At higher proportions of inclusion of tanniniferous legumes, crude protein degradation was drastically decreased. It is likely that such a decrease in protein degradation would result in a greater flow of non-ammonia N to the lower digestive tract of ruminants fed these mixtures. Provided a certain amount of the protein-tannin complexes actually gets dissolved and is available for digestion and absorption in the lower digestive tract, a higher proportion of these tanniniferous legumes in mixed diets could enhance animal performance. This hypothesis is currently tested in animal feeding trials.

Keywords: *In vitro* fermentation, legumes, protein, ruminants, tannins, tropical forages

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Species Diversity and the Ruminant Dry Matter Degradability of Grasses Fed to Fighting Bulls in Southern Thailand

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The research was conducted to elucidate the feed for species and the ruminal dry matter degradability of grasses that the farmers used as feed for fighting bulls in Nakhonsithammarat, Southern Thailand. Two consecutive studies were undertaken. The survey research was done in the first phase in four districts of Nakhonsithammarat (Mueng, Pra-Prom, Chalermprakiert and Thungsong) during October 2003 to February 2004. In all surveying areas sixty farmers who used the same basket type for grass collection were previously determined as the data collection sources. The collection of grass samples was done five times periodically and simultaneous in each surveying area. The grass samples obtained from each farm were classified according to the species. Only the principal grass species obtained from each farm of each surveying area were calculated as the percentage of grass species being used for bulls' feed of each location. It was found that only 10 species of the principal grasses were used for bull's feed in all surveying locations. The samples of the main grass species were prepared for the ruminal degradability study. These were *Hemarthria compressa*, *Microstegium ciliatum*, *Ischaemum magnum*, *Commelina diffusa*, *Hymenachne acutigluma*, *Ischaemum timorense*, *Brachiaria mutica*, *Axonopus compressus*, *Paspalum conjugatum* and *Pennisetum purpureum*. Among these species, *Hemarthria compressa* was the most popular grass that the farmer used for fighting bulls' feed in Pra-Prom, Mueng and Chalermprakiert districts, whereas *Microstegium ciliatum* was the grass that the farmers offered most frequently to the bulls in Thungsong district. When the sample grasses were used to study the ruminal degradability of the dry matter using the nylon bag technique, it was found that the potential degradability of the dry matter for all grasses species varied from 72.5 % for *Hymenachne acutigluma* to 87.8 % for *Axonopus compressus* ($p > 0.05$). These research results imply that the diversity of grass species for fighting bulls feed depends mostly on the location of the surveying area.

Keywords: Fighting bulls, grass species diversity, ruminal degradability, Thailand

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Development of Microbes that Degrade Mimosine from the Rumen Fluid of German Steers

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Leucaena leucocephala, a tropical leguminous plant, contains a toxic non-protein amino acid, mimosine. Successful utilisation of *Leucaena leucocephala* as a forage for ruminants depends on colonisation of the rumen by bacteria that degrade mimosine and di-hydroxy pyridine (2,3 DHP, 3,4 DHP), which are toxic intermediates in the metabolism of mimosine. The microflora in the rumen of animals in some parts of the world, however, do not include bacteria that are able to carry out this degradation. We thus describe a method to produce the microbes that can completely degrade mimosine from the rumen juice of German steers. Rumen juice of German steers was taken and frozen for one week. The fermentation was modified from Boever et al. (2000). Fermentation was started with 500 ml of rumen juice being treated with mimosine. The initial amount of mimosine to treat was 25 mg/day and increased by 25 mg every two days for two weeks until it became 200 mg/day. The medium (98–5) without mimosine was added continuously. The daily samples were taken to test the degradation of mimosine.

Samples (0.25 ml) of treated and untreated rumen fluid were inoculated in 10 ml of medium 98–5 with a mimosine concentration of 0.5 mg/L and incubated at 39 °C. The degradation of mimosine was determined daily with a colorimetric method daily by using a micro-colorimeter at A570 of FeCl₃ solutions of the different samples.

Only the samples treated with 200 mg/day of mimosine showed a degradation of mimosine at day 2 of the incubation period and the degradation was completed within one week. These findings showed that some ruminal microbes became adapted to mimosine when they were treated with mimosine and were able to carry out the degradation of mimosine.

The *in vivo* degradation of mimosine should be proved in an animal trial.

Keywords: *Leucaena leucocephala*, rumen microbes, mimosine, rumen juice

Forage Alternatives for Dry-Season Feeding of Dairy Cattle in Tropical Smallholder Farms in the Peruvian Andes

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Results of a preliminary study demonstrated that both milk yield and milk quality of cattle are impaired during the dry season in the Peruvian Andes. One main reason for these fluctuations is the variation in quality and quantity of the available feeds. The overall aim of this project is the development of efficient feeding systems for dairy cattle during dry season in the central Peruvian Andes. The following forage species have been identified as to be most promising to overcome feed shortage during dry season: *Avena sativa* (3 introduced varieties and local seeds), *Hordeum vulgare* (2 introduced varieties and local seeds), *Triticosecale* Wittmack, *Phalaris tubero-arundinacea*, *Lolium multiflorum*, *Vicia sativa*, *Medicago sativa*. These species have been established in January 2005 in experimental plots at two sites at 3770 and 3860 m asl. Two fertilizer treatments were applied: (i) no fertilizer and (ii) fertilizer application according to soil analyses and requirements of plants. The species were established in three replicates per site and fertilizer treatment, and were arranged in a randomized complete block design. Vigour of plants, soil cover, competitiveness against weeds and resistance against frost were evaluated and dry matter yield and contents of protein and neutral detergent fibre were determined. Mean dry matter yields (kg ha^{-1}) with and without fertilizer application were 5341 and 3107 for *A. sativa*, 5749 and 2254 for *H. vulgare*, 6601 and 2472 for *Triticosecale*, 1447 and 560, for *P. tubero-arundinacea*, 2524 and 903 for *L. multiflorum*, and 1344 and 1175 for *V. sativa*, respectively. Differences in dry matter yield within species by fertilizer treatment and site were significant ($p < 0.001$) whereas crude protein contents in dry matter were significantly different only between sites ($p < 0.001$). The mean protein yields achieved for the local varieties of *Avena* and *Hordeum* were 465 and 292 kg ha^{-1} , with the crude protein contents amounting to 128 and 163 g kg^{-1} , respectively. The introduced varieties of *Avena* and *Hordeum* showed mean protein yields of 467 and 496 kg ha^{-1} , with protein contents of 113 and 126 g kg^{-1} , respectively, underlining the superior quality of the introduced varieties of *Hordeum*.

Keywords: Dairy production, dry season feeding, forage species, Peru

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Threonine Requirement of Intensive Broiler Genotypes at Different Age and Sex Depending on Performance and Efficiency of Threonine Utilisation

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Due to high cost of protein and environmental pollution, proper formulation of amino acids in animal feed has been a great interest to nutritionists. Threonine as the third limiting amino acid after methionine and lysine based on soybean meal has been intensively studied in growing broiler. The results vary between studies depending on the diet, age, sex, breed of animals and method for evaluation of the requirement. Based on the efficiency of the limiting amino acid, the amino acid requirement can be determined within the exponential N utilisation model. The objective of this study was to investigate threonine requirement of intensive broiler genotypes at different age and sex depending on performance and efficiency of threonine utilisation. The calculation of threonine requirement data was based on the exponential N-utilisation model from N rise experiments with totally 288 growing chickens of different sex (Cobb 500). The diets were based on HP soybean meal with supplementation of L-lysine and DL-methionine. Threonine concentration ($c=3,87 \text{ g} / 16 \text{ g N}$) and the relative amino acid pattern (Lys : Met+Cys : Thr = 1 : 0,85 : 0,54) identified threonine as the limiting amino acid in all diets. The results give a first indication that the threonine requirement between the age and sex could be different. The requirement of threonine based on metabolic body weight reduced with the increase of age. This observation might be affected also by the variation of threonine efficiency, calculated based on the mathematical estimated function between N intake and N retention for each N-rise experiment of the study. The results have to be approved in growth trials with determination of nutrient deposition and under conditions of varying Thr efficiency.

Keywords: Age and sex, broiler, threonine requirement

Antinutrients Present in Unconventional Fodder Leaves from Bangladesh Alter Rumen Fermentation Characteristics *in Vitro*

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Unconventional plants are increasingly recognised as high quality feed resources in tropical countries and as a potential source of compounds that affect rumen fermentation. Often, secondary compounds reduce the nutritional value of the plants but on the other hand may become useful to protect dietary protein from microbial degradation in the rumen and thus increase the protein supply to the ruminant. This study aimed at unravelling the effects of antinutrients on rumen fermentation parameters *in vitro* with special emphasis on protein metabolism.

Fourteen Bangladeshi fodder plants were screened for their contents of nutrients and anti-nutrients and 5 leaf materials were selected for further investigation and extraction of the respective compounds: *Syzygium cumini* for its content in total tannins (TT), *Artocarpus heterophyllus* for condensed tannins (CT), *Acacia nilotica* for hydrolysable tannins (HT), *Sesbania aculeata* for saponins (SAP) and *Eichhornia crassipes* for non-starch polysaccharides (NSP). TT, CT and HT were extracted with acetone and purified with Sephadex LH 20. SAP were extracted with methanol, chloroform and butanol, while NSP were extracted enzymatically. *In vitro* incubations were performed with the Reading Pressure Technique using bovine rumen fluid and a substrate composed of maize silage, barley grain, soybean meal and BSA. Either ground leaves replacing the silage (27 % inclusion) or plant extracts were added. The production of gas and short-chain fatty acids (SCFA) and the kinetics of protein and ammonia concentration were monitored over 12 hours.

All additives decreased gas production, the effect being highest with *S. cumini*, which also caused the strongest decrease in total SCFA production. TT, CT and HT protected protein from degradation by precipitation, with the protein precipitation capacity being highly correlated to the content of TT determined by ferric chloride assay and being highest in *S. cumini*. The concentrations of ammonia and branched SCFA were decreased strongly by TT, but only slightly with CT and HT, and increased with SAP and NSP. Detailed studies on the interactions of the extracted compounds are in progress.

Keywords: antinutrients, *in vitro*, protein degradation, rumen fermentation

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Cactus Pear (*Opuntia ficus-indica*) as a Complement to Urea-Treated Straw in Dry Season Feeding Systems of Ruminants

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Ethiopia's livestock population, the largest in Africa, is contributing little in ensuring food-security, mainly attributed to poor feed quality and unavailability. Due to its adaptability, cactus pear established its own environmental niche on marginal lands in arid areas of Ethiopia and elsewhere. It is widely used as forage, especially during critical periods of feed shortage. Compositionally, cactus pear is rich (dry matter basis) in readily digestible carbohydrate. The other abundant feed resources are cereal residues, which are of low nutritive value. Urea-treatment has been proposed for enhancing their quality. Lack of readily digestible organic matter, which cactus pear has, limits the efficient utilisation of urea-treated straw. Thus, this study aimed at investigating the complementarity of cactus pear and urea-treated straw. A three-months experiment, laid out in a randomised complete block design with eight sheep/treatment, was conducted to assess the effects of cactus pear (C), untreated wheat straw (S), urea-treated straw (UTS)(5 % urea) or wheat bran (WB) on intake, digestibility and growth. Diets consisted of S (T1), S+C (T2), S+C+WB (T3), UTS (T4), UTS+C (T5) and UTS+C+WB (T6). The rate of supplements (C and/or WB) was 40 %. Diets were offered in individual throws twice daily, aiming at 20 % refusals. At the end of the feeding trial, four sheep/group were transferred to metabolic crates for the digestibility trial (7 days). Data were analysed using the SAS software JMP5. Urea-treatment improved crude protein content of straw from 2.7 to 8.7 % and apparent dry matter digestibility (DMD) from 55% (T1) to 65% (T4). Highly significant differences ($p < 0.001$) were observed for total dry matter intake (DMI), DMD and liveweight change. DMI was highest in T5 and T6 (90 and 84 g/kg $W^{0.75}$, respectively) and lowest in T1(55 g/kg $W^{0.75}$). DMD was highest in T2 and T5 (65 %) and lowest in T1 (55 %). Sheep on T6 had the highest liveweight gain (75.5 g/day) followed by sheep on T3 and T5 (41.5 and 38.0 g/day). In conclusion, cactus pear and urea-treatment significantly increased total feed intake. Cactus pear could substitute wheat bran, provided that straw is urea-treated. Diet T6 appears to be a promising package for dry season feeding systems that could enhance productivity of livestock and thereby improve the livelihood of farmers.

Keywords: Cactus pear, digestibility, Ethiopia, feed intake, liveweight change, straw, urea-treatment, sheep, wheat bran

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Urban Cattle Fattening System

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A study was conducted to understand urban cattle fattening systems in Arsi-Negle town located 225 km south of Addis Ababa, the capital of Ethiopia. Forty households were randomly selected from 3 kebles (smallest administrative units) for personal interview using semi-structured questionnaire. General issues related to cattle fattening were obtained through group discussion with key informants.

It was found that 75 % of the respondents were engaged in 'katikala' production (alcoholic beverage produced by distillation process). The process involves series of tedious steps all of which are done by women. The by-product of the distillation process 'atella' is widely used as animal feed. Seventy percent of households producing katikala were engaged in cattle fattening. The daily amount of 'atella' produced per household was 200–600 litres. Households producing higher quantities use the entire atella produced for fattening. Crop residues mixed with atella include barley, teff, and wheat straw.

Two age groups of fattened cattle were identified. Households (HH) having farm plots at the periphery of the town (48 % of households) fatten oxen at the end of their working period. On the other hand, HH not engaged in crop cultivation purchase young animals for fattening. Animals are fattened in a cyclic way i.e. new animals to be fattened are purchased only after selling the previous ones. The duration of each cycle is 2–4 months with a mode of 3 months. Number of cattle in each cycle varied from 2–4 with a mean of 2.5.

This system seems to work well for most families but is facing problems because of environmental concerns. Appropriate waste management practices and provision of alternative source of energy to decrease the rate of deforestation caused by the high fuel requirement of the distillation process need to be put in place to sustain the system.

Keywords: Atella, cattle, fattening, waste management

Effect of Sex and Slaughter Weight on Pork Quality of Swine Received Tuna Oil During Growing and Finishing Period

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The objective of this study was to increase ω -3 unsaturated fatty acid content in pork by evaluating the effects of diet, sex and slaughter weight of growing-finishing pigs. The experiment was conducted in a 2x2x3 factorial arrangement of treatments in Randomized Complete Block Design (RCBD) which included diet (0 vs. 2% tuna oil inclusion), sex (barrows and gilts) and slaughter weight (90, 100 and 110 kg). Ninety-six crossbred swine were randomly divided into 12 groups of 8 pigs each and used in the study. The pigs were fed individually giving 8 replications per treatment. According to treatment the pigs were slaughtered as they attained weights of either 90, 100 or 110 kg and the meat quality was assessed. Meat quality in terms of pH of *M. longissimus dorsi* and at 45 minute post mortem of the control group was higher than that of the tuna oil group across slaughter weights and sex (6.55, 6.40 and 6.58, 6.46 respectively; $p < 0.05$). Meat redness score (a^*) of *M. longissimus dorsi* of swine slaughtered at 90 kg was less than those slaughtered at 100 and 110 kg (6.34, 7.12 and 7.33 respectively; $p < 0.01$). The fat percentage of the tuna oil group was higher than that of the control group (1.86 vs. 1.66; $p < 0.05$) across slaughter weight range and sex. In addition, fat percentage of barrows was higher than that of gilts (1.86 vs. 1.65; $p < 0.05$) across the slaughter weight range.

Meat from the slaughter weight group of 110 kg had higher shear force value than those of 100 and 90 kg (42.32, 39.23 and 37.24 N respectively; $p < 0.001$) irrespective of sex and diet group. Sensory evaluation of barrows was better than that of gilts in terms of tenderness (6.18 vs. 5.89; $p < 0.001$) and juiciness (5.82 vs. 5.62; $p < 0.05$) across diet and slaughter weight groups. Thiobarbituric acid (TBA) values of meat from the tuna oil group at day 6 and 9 was higher than that of the control group ($p < 0.01$) irrespective of sex. Meat obtained at a slaughter weight of 110 kg tended to be rancid irrespective of sex and diet. Triglyceride content of barrows was higher than that of gilts (1.87 vs. 1.57 g/100 g; $p < 0.05$) at all slaughter weights. In conclusion, barrows fed with tuna oil from 30-100 kg gave a favourable meat quality.

Keywords: Carcass quality, fish oil, growing-finishing pig, ω -3, productive performance

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Adoption and Impact of Forage Conservation Technologies Transferred with Contrasting Extension Approaches: A Current Research Project in Honduras and Nicaragua

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In extended areas of Central America feed shortage during the 5–6 month dry season severely limits livestock production. Alternative strategies to increase milk and meat production include hay and silage preparation for the dry season. However, due to required high investments, adoption of forage conservation methods by small-scale farmers has been low.

A research project in Honduras and Nicaragua aims at enabling small-scale farmers to adapt forage technologies to local conditions and meet the large demand for dry season feed. Production, conservation (in form of hay and silage) and marketing of improved grasses (*Brachiaria brizantha* cv. Toledo and *Brachiaria* hybrid cv. Mulato) and forage legumes (*Vigna unguiculata*, *Lablab purpureus* and *Cratylia argentea*) are promoted for groups of small-scale farmers using two contrasting extension strategies. The first strategy promotes a single best-bet solution technology package of a conserved high quality feed (e.g. a legume-grass mixture) packed in locally available plastic bags, whereas the second strategy consists of the development of locally suitable technologies through offering different promising alternatives and explaining the technical backgrounds to farmers who can then decide which one suits them best and make adjustments according to their specific situation. It is hypothesised that greater success occurs when innovation processes are facilitated through an interactive and experimental learning process involving modification, selection and promulgation of a promising technology by the users themselves rather than focusing on the promotion of rigid packages. Adoption, costs and benefits of both the technologies and R&D and extension strategies will be evaluated leading to recommendations for agricultural research and extension. Currently, experimenting with the new forage options has started and effects on milk production and live-weight gain are measured. Once farmers have begun to adopt their locally developed solutions, the successful technologies and innovation strategies will be scaled up through multi-actor interactions.

Keywords: Central America, extension, forage conservation, innovation

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Livestock Genetic Resources

- WORKNEH AYALEW, ADAM DRUCKER, CLEMENS WOLLNY, OLOROUNTO D. KOUDANDE, FAUSTIN VIDOGBENA, HIP-POLYTE DOSSA, LEMMA GIZACHEW, ULFINA GALMESSA, GIRMA TESFAHUN KASSIE, BRIGITTE KAUFMANN, HARUN WARUI, GUYO HARO:
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Improving the Livelihoods of Poor Livestock-Keepers through Community-Based Management of Indigenous Farm Animal Genetic Resources in Africa

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More than 70 % of poor rural farmers and pastoralists in Africa depend on livestock to secure part of their livelihoods. The contribution of livestock to agricultural GDP reaches 80 % in some Sub-Saharan African countries. The demand for livestock products in Africa is expected to rapidly increase over the coming decades, and poor livestock-keepers and their indigenous breeds have the potential to play a prominent role in meeting such demand. The loss of genetic diversity reduces opportunities to improve food security, reduce poverty and shift towards sustainable agricultural practices. It is argued in this paper that the community-based management (CBM) of existing animal genetic diversity in developing countries can support the improvement of the livelihoods of poor livestock keepers while also ensuring the conservation of the genetic resources. The paper presents highlights of the structure and progress of a broad collaborative and participatory research project, which seeks to overcome past failures in the genetic improvement of animal genetic resources (AnGR) by developing a framework to fully engage communities and test preferred solutions in the *in-situ* management of these resources, an approach consistent with the Convention on Biological Diversity. This interdisciplinary project combines novel approaches to implement CBM, including, inter alia: participatory documentation of livestock breeds and indigenous knowledge to mobilise community resources; characterisation of livestock genetic resources in the systems context; economic valuation of the traits preferred by indigenous livestock keepers and participatory livelihood contribution assessments for evaluating the impact of livestock development interventions. It also tests alternative institutional arrangements in the management of AnGR. The project

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is being implemented in Benin, Ethiopia and Kenya. In Kenya the project works with the Gabra pastoral communities on indigenous sheep and goats. In Ethiopia the focus is on Horro cattle in a sedentary highland crop-livestock production system. In Benin, the project works on indigenous small ruminants and chicken with smallholder mixed crop-livestock farmers in warm and humid climatic zones. Population density is high and access to market and veterinary services is limited. The lessons learned under these diverse production environments will ensure its broad applicability in developing countries.

Keywords: Africa, community-based management, conservation, indigenous animal genetic resources, livelihoods

What Matters in the Realisation of a Communal Dairy Breeding Programme in the Tropics?

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Adapted communal breeding programmes could be a powerful mean to increase dairy cattle productivity in a sustainable way and at the same time to maintain local genetic resources. The essential steps of a breeding programme consist in breeding goal definition, choice of selection criteria, organisation of a performance recording service, use of the information for selection, and dissemination of genetic response. Procedures and descriptions how to carry out these steps are well established and successfully applied for certain species in certain countries under certain conditions. However, the realisation of these steps under tropical smallholder conditions still poses a great challenge for any community striving for a genetic improvement programme.

The objective of this work is to specify the practical implications of performance recording for dairy smallholders in the tropics with regard to technical issues.

Animal recording for breeding purposes presupposes the assignment of an observed or measured performance, as well as important information on systematic effects and kinship to the candidate. These information have to be adequately registered and analysed. However, organisational and institutional structures in most developing countries are not fully established and functioning. Appropriate alternatives for superior animals for the selection of breeding animals for dissemination are discussed. These involve the aspects of animal identification including ancestors, the determination of performance traits and important systematic effects, the registering of data, database and data analysis. Hereby an adequate level of sophistication as well as an appropriate assignment of tasks has to be ascertained. On the other hand an adequate mating service based on the identified breeding animals is needed. In this connexion issues like the creation of genetic links, avoidance of inbreeding, mating relations, etc. have to be considered.

Keywords: Animal recording, breeding programme, dairy, smallholder

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Breeding Practices and Trait Preferences in Smallholder Pig Production Systems in Mountainous North-West Viet Nam

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Low and unsteady resource availability limits smallholders' possibilities to extend pig production in mountainous areas of North-West Viet Nam. One possibility to increase production efficiency is the development of appropriate breeding programmes integrating genotypes that fit prevailing production conditions and being able to perform the multiple roles of pigs. Many important functions of local breeds are embedded in non-marketable traits, often ignored in such programmes. By integrating local breeds into village breeding programmes, important genetic resources can be preserved in their natural habitat. This study aimed at understanding smallholders' breeding practices and objectives as well as trait preferences for female breeding stock in order to guide the development of appropriate breeding programmes and to assess the future role of the local Meo breed for such programmes. The study covered six villages following a production gradient from demand-driven to resource-driven pig production. A total of 140 pig keepers were approached by interviews using structured questionnaires and by choice experiments. Descriptive statistics of collected data were calculated and NLOGIT 3.0 econometric software was used to estimate trait preferences. The local Meo was the main breed of smallholders in resource-driven production systems. Though being appreciated for its productive adaptability, smallholders stated to prefer higher-yielding genotypes. Uncontrolled natural mating was predominant. In contrast, breeding practices in the demand-driven pig production system reflected smallholders' efforts to maximise the proportion of improved genotypes. Mong Cai sows were predominantly used, being appreciated for their reproductive performance and adaptability traits. Common breeding practice was their crossbreeding with exotic boars, either by natural mating or artificial insemination. Important pig breeding traits across different production systems were adaptability to fibre-rich diet and disease resistance, as well as reproductive and productive traits. Outer appearance tended to be less important. Results suggest that important traits in developing breed improvement programmes should include adaptability and performance traits. However, as smallholders' breeding practices and trade-offs between pig breeding traits differed across production systems, the integration of the Meo breed into breeding programmes only seems promising in resource-driven production systems.

Keywords: Breeding practices, choice experiments, local Meo breed, North-West Viet Nam, smallholder pig production, sustainable breeding programmes, trait preferences

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Molecular Marker-Based Genetic Diversity Assessment of Thai Native Chicken and Broiler Chicken

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The World chicken meat market is characterised by numerous quality marks: “Label de Qualite Wallon” in Belgium and “Label Rouge” in France, denominations of geographical origin, organic agriculture, etc. Most of those certified productions have specifications requiring the use of slow-growing chicken strains. Such as Thai native chickens have tough and strong muscles, low fat contain and free of antibiotic. The objectives of this research were to employ Amplified fragment length polymorphism (AFLP) to assess the genetic diversity between Thai native chickens and fast-growing broilers. Two restriction enzymes (EcoRI/TaqI) were used for double digestion and 50 selective primer combinations with two and three selective nucleotides were tested on individual DNA samples from chicken products essentially in carcass form that were ascribed as belonging to either slow (Thai native chicken) or fast-growing strains (Broiler). Within the resulting of AFLP fingerprint profiles were analysed on polyacrylamide gel electrophoresis and visualised by silver staining, each combination of primer generally produced 102–220 bands. The AFLP fragments ranged from 50 to 700 bp in length. Two AFLP fragments were identified as type-strains specific markers. The E-ACT / T-CAT primer combination gives a band (270 bp) that is specific for slow-growing chickens, and another AFLP fragment generates a band (250 bp) that was found to be characteristic of fast-growing chickens. The two specific AFLP markers will be isolated, re-amplified, cloned, and sequenced. The effectiveness and the specificity of the two interesting determinants were assessed further on another individuals of both strains. Moreover, genetic diversity of Thai native chicken and broiler chicken will be discussed.

Keywords: Amplified fragment length polymorphism, broiler, genetic marker, Thai native chicken

Sequencing and Mutation Screening in Exon 1 of Camel Tyrosinase Gene

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The tyrosinase (TYR) represents a decisive factor in the metabolic pathway leading to coat colour pigmentation as well as in hormone production. Mutations in the tyrosinase gene are responsible for the albino phenotype in the mammalian and they are also known to influence quantitative traits in mice. Based on the partial sequences of mouse and human it was possible to design a primer pair which could be used for the amplification of a 820 bp fragment in the exon 1 of the camel tyrosinase gene. The resulting camel tyrosinase sequence shows a high homology to the corresponding sequences of mouse (84.2 %), human (88.7 %), horse (89.3 %), cattle (90.1 %) and pig (91.9 %) respectively. By sequencing of 15 animals from different camel breeds a single nucleotide polymorphism (C/T) on position 200 after the ATG causing an amino acid substitution (Pro/Leu) was detected. A restriction site for Dde I provoked by the C-variant of this mutation could be used in a special restriction fragment length polymorphism analysis (PCR-RFLP) for genotyping of 157 animals from six different Pakistani camel breeds (Marecha, Dhatti, Larri, Kohi, Campbelpuri and Sakrai). Significant differences in the genotype frequency between the breeds were estimated. The Sakrai breed shows in comparison to Marecha, Dhatti, Larri and Kohi a distinctly higher frequency of the CC-genotype (CC = 0.40; CT = 0.56; TT = 0.04). Possible associations of these Dde I-genotypes with coat colour and special performance traits (like morphological characteristics or features for growth and production) will be elucidated and the results will be shown.

Keywords: Camel, genotyping, point mutation, sequencing, tyrosinase

Performance Traits of Different Pakistani Camel Breeds

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Pakistan possesses about 1.2 million camels in more than 20 breeds representing approximately 23 % of the whole camel population of Asian countries. Recently annual population growth rates of 1.62 % were observed. In this investigation performance traits of six camel breeds (Marecha, Dhatti, Larri, Kohi, Campbelpuri and Sakrai) from different zones of the country were studied. These traits included some of the morphological characteristics, somatometric measurements as well as features for growth, production, reproduction and draught power. Significant differences could be calculated in the performance of various camel breeds. Results show a shorter neck, girth, height and length ($p < 0.001$) of the Kohi camels than that of the others; where—as the size of hump was smaller ($p < 0.001$) in Campbelpuri breed. Male calves of Campbelpuri breed were heavier ($p < 0.001$) at birth. Marecha breed shows a higher ($p < 0.001$) lactation yield and longer ($p < 0.001$) lactation length. However, the age at puberty in the Kohi females was significantly lower ($p < 0.001$) than in Dhatti and Larri breeds, ($p < 0.01$), Marecha and Campbelpuri and ($p < 0.04$) Sakrai camels. Marecha females showed a longer gestation period ($p < 0.001$) than Larri, Kohi, Campbelpuri and Sakrai, and also ($p < 0.02$) Dhatti. Kohi females produce more calves during their life span ($p < 0.001$) than Marecha, Dhatti, Larri, Sakrai, and ($p < 0.03$) Campbelpuri female. A longer dry period ($p < 0.001$) occurs in Kohi females. Dhatti females show longer calving interval ($p < 0.02$). Number of mountings per day was calculated for each male from all six breeds. It is higher in Kohi males ($p < 0.001$) than that of the Marecha, Dhatti, and ($p < 0.02$) Sakrai. Kohi breed produces relatively more hair ($p < 0.001$) than all other breeds included in this task. Riding speed of various camels was calculated and Kohi camels were found to be slower ($p < 0.001$) than Dhatti, ($p < 0.01$) Marecha and ($p < 0.02$) Campbelpuri camels.

Keywords: Breed differences, camels, performance traits, Pakistan

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Livestock Breeds and Genes on the Move: Exchanges Between North and South

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Drawing especially on data about Germany, this paper summarises the findings of a study on the exchanges of livestock and poultry breeds and their genetic materials between the North and the South in recent history. Particular focus is given to smallholder keepers in the South because they have been crucial to breed development in non-temperate climatic zones and millions of them depend on livestock for their livelihoods. Data were collected through literature searches, the analysis of statistical information, and informal interviews. The findings indicate that in the 20th century the quantity of gene flows from South to North appears to have been smaller than the number of animals, semen, embryos and eggs shipped from the North to the South. However, despite the extensive flows, impact in the South has remained limited and benefits mostly by-passed pastoralists and poor livestock keepers. Examples from the North indicate that it may not need large amounts of genetic materials to establish breeds that can make an economic difference. Factors determining the outcome of a breeding programme include how it is planned and implemented, whether a breed is suited for the new environment and fits in with the goals and strategies of the producers; and whether a country is offering institutional and legal support to its producers. Unfortunately governments in the South tend to favour livestock industrialisation at the expense of smallholder producers. International agreements regulating agricultural trade are likely to enhance such trends and increase gene flows to the South. Furthermore, with progressing intensification and industrialisation breeding decisions are increasingly taken out of the hand of farmers and herders. However, their involvement remains crucial for the continuation of the development of breeds adapted to natural environments and for the maintenance of breed diversity. To support smallholder keepers, governments in the South need to recognise the smallholders' contribution to breed development and secure their access to grazing and water, services and education. Governments also need to ensure that the access and free exchange of genetic materials do not become restricted by patents on animals, genes and breeding strategies.

Keywords: Agrobiodiversity, animal genetic resources, breed exchanges, breed movements, crossbreeding, gene flows, livestock development, pastoralists, smallholder producers

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Global Exchange of Sheep Genetic Resources

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Exchange of animal genetic resources has taken place since domestication of livestock. However, advantages and disadvantages of gene flow regarding food security and poverty reduction have not yet been assessed. The study attempts to understand the historical development and current status of gene flow in sheep and is an excerpt of the study “Gene flow in animal genetic resources — A Study on Status, Impact, Trends” commissioned by the BMZ/GTZ and FAO. Data were obtained from the Eurostat statistic database, from ten FAO Country Reports on the State of Animal Genetic Resources and from contacts to six breeding organisations and 21 experts from 12 countries. Additional information came from publications. The influence of domestication, breed formation, human migration, and breeding methods on diversification of sheep were studied. The current status was indicated by export and import of genetic material, and influence of foreign genetic material in existing breeds.

It was shown that ancient historical gene flow resulted in the characteristic diversification of sheep. Demand for superior breeds promoted gene flow and existed throughout time. Need for improvement of productivity resulted in an intensive global exchange of genetic stock and caused the increasing diversification of many sheep populations. A current influx of genetic material into many regions of the world was generally based on breeds coming from developed countries. Access to improved breeds took place by developed and developing countries. Impact of introduced breeds depends on their suitability to prevailing production systems. Gene flow from developing countries occasionally took place when a superior genetic resource was available without preceded systematic improvement processes. Gene flow globally contributes to the diversification of national sheep populations. If the suitability for prevailing production systems is given, gene flow of improved breeds contribute to poverty reduction and replacement of local breeds in developing countries. If it is not given, the economic situation of smallholders deteriorates through dilution and replacement of their indigenous genetic resources. This has occurred in single cases. However, the global gene flow of sheep genetic resources has not led to a threat of extinction of most local sheep breeds, namely in developing countries.

Keywords: Animal genetic resources, breeding stock, dissemination, gene flow, hair sheep, Merino, sheep, transfer

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Comparison Between *Bos Taurus* and *Bos Indicus* by Microsatellites and Casein Haplotypes

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The analysis of casein haplotypes as well as private microsatellite alleles, provides an efficient tool for a discrimination between *Bos indicus* and *Bos taurus* populations. We analysed the genetic diversity of 22 taurine and indicine cattle breeds at three zebu- and African taurine-diagnostic microsatellite loci and three casein genes, and we studied possible indicine and African taurine introgressions into Southern European cattle breeds. Consideration of recently described genetic variants of the casein genes, to date not subject of diversity studies, allowed the identification of still undescribed haplotypes mainly in *Bos indicus* breeds. This study adds another point of view on the phylogeny of cattle. Results prove a genetic introgression of *Bos indicus* into South Eastern European cattle. Genetic relationships of South Western European breeds with African taurine breeds, may be assessed as the result of selection effects rather than gene flow. The occurrence of a taurine-indicine hybridisation zone contributes an alternative explanation of the high variability of breeds near the alleged centre of origin.

Keywords: *Bos indicus*, *Bos taurus*, casein haplotypes, genetic diversity, microsatellites

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Conflict in Resource Use among Livestock and Crop Farmers in West Africa

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Nigeria, like many agrarian countries in Africa, is experiencing high population growth with an accompanying increased demand for arable cropland. The need to provide food of crop and animal origin to meet ever-growing demands necessitates opening up of lands hitherto uncultivated including marginal lands. In many cases, especially where high population densities have led to overcrowding of existing farmlands, agricultural intensification has inevitably resulted. This kind of population-driven agricultural intensification often necessitates the adoption of certain farming techniques such as irrigation procedures and the adoption of agro-chemicals or improved organic farming techniques. Farmlands that were left to fallow for natural regeneration of the soil nutrients are fast disappearing so also are grazing lands, which have traditionally provided dry season grazing to pastoralists.

This changing pattern of agricultural production occasioned by population and/or market driven intensification has recently adopted measures for increased dry season irrigation farming for the promotion of agricultural growth through conjunctive exploitation of surface and shallow aquifer water resources for small holder farm-owned and managed small-scale irrigation development cited in wetland areas. Such lands have alternative and competitive uses by different producing groups. With the advent of the dry season irrigation project, pastoralists and other groups have been denied access to this dry season grazing resource. The competitive uses to which wetland is put is the source of potential and real conflicts amongst the various rural land users. Furthermore, the development of the wetland areas is an interference on the ecosystem which has the potential of adversely affecting plant and animal species bio-diversity. Thus, a conflict between environmentalists and the actual landless is an issue to contend with. Using the Nigerian irrigation project experience, this paper presents the different facets of conflict arising from resource utilisation and the principal actors involved. The various modes of conflict resolution are presented with a discussion of the merits and demerits of each settlement mechanism. Mitigative measures are also presented and discussed.

Keywords: Conflict, crop and pastoral production, irrigation, resource use

The Potential of Integrated Agriculture Aquaculture (IAA) to Support Sustainable Land Use in National Park Peripheral Areas — A Case Study from St. Paul National Park, Palawan, Philippines

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Development interventions promoting integrated agriculture aquaculture (IAA) have become increasingly popular in order to tackle resource degradation and poverty in agricultural communities all over the developing world. In many places, national park peripheral areas compete with the agricultural sector, which is the predominant source of income in rural areas. In this connection there frequently is much more than a simple conflict to be solved. The prevailing abundance of natural resources is often confronted with non-existent labour markets and rural poverty. Derived out of individual human emergency situations, these circumstances can lead to ruthless resource use practices (e.g. illegal logging, cyanide- and dynamite-fishing), nowadays well known in the Philippines. New practicable possibilities to face this alarming development have to be elaborated. Methods which both secure the environment from further destruction on the one hand and ensure the provision of income alternatives on the other hand. This presentation will demonstrate the potential of an ecologically sound IAA production system in order to provide a sustainable source of income for small scale farmers and people of other related sectors. Simultaneously, the implementation of IAA is able to contribute to lessen the pressure on the natural resource base. A bundle of criteria has to be taken into account in order to successfully implement the development activities in the project region. Focussing on the procedure of modelling an adequate production system, an example is shown on a pilot project site near St. Paul National Park on the island of Palawan, southwest Philippines. In this context the designing of production activities on the experimental site will be described. Furthermore an evaluation at farm scale and the formulation of different scenarios will give an idea about the great potential of the analysed system to meet the objectives.

Keywords: Income generation, integrated agriculture aquaculture, national park peripheral areas, Philippines, sustainable land use

Phytoremediation of Petroleum-Contaminated Soils in the Tropics

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Phytoremediation is a non-destructive and economic *in situ* technology that uses plants to remove, degrade or stabilise contaminants in soils. In oil-contaminated soils, it is based on the stimulation of microbial degradation in the rhizosphere. Although phytoremediation is especially promising for the tropics due to climatic conditions that favour plant growth and microbial activity, research was so far mostly limited to the temperate zone. Furthermore, factors controlling the process and success of phytoremediation are still not well understood. The presented project was a co-operation of the University of Hohenheim and PDVSA-Intevep (Centro de Investigación y Apoyo Tecnológico de Petróleos de Venezuela S.A.). The studies were carried out with plants and soil from the savannah of eastern Venezuela. Results are expected to assist in the development and application of phytoremediation not only in Venezuela but also in other tropical countries. After the pre-selection of plants collected on crude oil contaminated sites, species with characteristics promising for phytoremediation were screened in a greenhouse experiment for their ability to increase the degradation of petroleum hydrocarbons in soil. Soils planted with the pasture grass *Brachiaria brizantha* showed a significantly lower oil concentration after 180 days than unplanted soil. In subsequent expanded experiments with *B. brizantha*, fertiliser levels were adjusted to obtain best plant growth and highest oil dissipation. Microbiological studies of rhizosphere and non-rhizosphere soil showed that *B. brizantha* had a prevalently increasing effect on microbial numbers, especially on fungi. Since they tolerate lower pH values than bacteria, they are considered to play a central role in oil degradation, especially in acid savannah soils. Analysis of carbon source utilisation patterns showed different microbial community structures in rhizosphere vs. non-rhizosphere soils. In particular, D,L- α -glycerol phosphate was more used in the rhizosphere, pointing to a higher availability of phosphorus, which is essential during oil degradation but scarce in savannah soils. Although greenhouse experiments help to clarify some important issues of phytoremediation factors and mechanisms, field trials are considered indispensable for the investigation of phytoremediation. Future research issues should include fertiliser composition and the particular role of fungi in phytoremediation of acid savannah soils.

Keywords: *Brachiaria brizantha*, oil contamination, petroleum hydrocarbons, phytoremediation, rhizosphere

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Towards Endogenous Development: Borana Pastoralists' Response to Environmental and Institutional Changes

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Pastoral rangeland management has been weakened by poorly adapted development interventions, inadequate land use policies and population growth. Ignoring pastoralists' technical and organisational capacities has contributed to progressive degradation, the erosion of social structures and poverty. Many stakeholders and scientists nowadays promote endogenous development based on pastoralists' strategies and innovative approaches. This paper explores adaptive strategies of Borana pastoralists in response to environmental and institutional change in southern Ethiopia. The study was conducted from 2000 to 2002 in co-operation with the Borana Lowlands Pastoral Development Programme (BLPDP/GTZ). Present land use strategies and institutional networks were compared to past patterns, using participatory appraisal, official maps, GIS and household surveys. Stakeholder workshops provided a platform to identify priorities for pastoral oriented development. The opening of water dams in Dida Hara in the 1970s led to a permanent use of former exclusive rainy season grazing areas. While principles for water management were transferred from traditional deep wells to newly constructed dams, the scattered establishment of new encampments counteracted traditional rules. In the early 2000s, pastoralists have started attempts to reorganise settlements clustering encampments in line in order to avoid further fragmentation of the common grazing areas. The decrease of cattle numbers per person below the threshold of survival accelerated cropland expansion into valuable grazing areas. In response to this development, the Borana courts accepted crop cultivation as a means to cope with the increasing food insecurity, but only in restricted areas. The courts also accepted cooperative grazing reserves to feed weak animals during dry season periods, but forbade individual appropriation of communal rangelands by fencing. The rapid degradation of rangelands motivated pastoralists to adopt camels with positive effects on herd mobility. Although indigenous institutions have lost influence and conflicts between Borana elders and local governments have occurred, in some districts joint consultations for a coordinated land use were initiated. These examples show that pastoral organisation has the potential to form the backbone for endogenous development. Together with external actors such as development and government agencies they are now challenged to develop more sustainable and diverse land use strategies and redefine institutional responsibilities.

Keywords: Common property, endogenous development, Ethiopia, indigenous knowledge, institutional change, pastoral rangeland management

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“Barren Hills” in Vietnamese Science and Legislation: A Synthesis

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With the agricultural flatland already fully exploited, meeting the long-term food demand for the growing population of Viet Nam has to rely on rehabilitation and utilisation of degraded land in the mountainous areas. “Barren hills”, the keyword for land degradation in the uplands, have, over the last decade, been explicitly referred to by two large-scale national programmes and five ambitious international development projects, even by the Vietnamese Land Law. Nevertheless, it is not clear what barren hills are; they do not appear in the official statistics, and the context of their occurrence is insufficiently known.

Available legal, scientific and policy documents were integrated to build a concept of barren hills. Out of the “unused” (after more than three years of being left idle) land from the census data we show that four types (defined by land cover) of barren hills account for 77 % (i.e. 23 % of total land in Viet Nam); only about 11 % of them are deemed non-reclaimable. Appearing almost exclusively in the place of former forests, a quarter of barren hills area is already degraded to sparse herbaceous cover, or even stone outcrops. Forest loss was attributed to six major identified causes with different extents across the country. Interestingly, agricultural activities of the local uplanders have on average caused only 14 % of forest loss; in the most severely degraded Northern Mountains region, more than 40 % has been due to migrations (state-aided more than uncontrolled).

Current policies heavily rely on local farmers to rehabilitate degraded, unused land. However, farmers were willing to receive, in the process of land allocation, only a third of this land, and often failed to reclaim the allocated areas. Policy improvements to increase the participation of farmers in barren hills rehabilitation will have to address the roots of their aversion: poverty and food insecurity, insecurity in user and usufruct rights, and insufficiency of extension support. To provide an effective basis for land use planning, existing land evaluation standards need to be modified, as they currently can not distinguish among barren hills types.

Keywords: Barren hills, land degradation, land management, Viet Nam

Participatory Survey of Allocated Degraded Land in the Northern Mountains of Viet Nam: The 3:3:3 Pattern

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Since 1993, strategies to rehabilitate degraded land in Viet Nam rely on allocating this land to farmers, who should presumably be willing to accept it and capable to reclaim and utilise it according to the specified purposes. The allocation, however, has in general been rather slow, and actual possibilities to monitor the use of such land are only very limited (land census every five years). In this context, an insight into processes and driving forces of land use dynamics at the farm level is important.

In the Northern Mountains, the region most severely affected by degraded “barren hills”, four selected communes, stratified by the presence of rehabilitation projects, represent the regional diversity of ethnic groups and natural conditions (in the provinces Son La and Bac Kan). The participatory survey included 109 households with allocated degraded land. Farmers motives to receive barren land (envisaged incentives from projects and lack of arable land), and perceived reasons for reclamation failures (poor soils, lack of inputs, labour and know-how) do not principally differ among the households. Range, extent, and particularly success of utilisation approaches, however, show a clear effect of the activity of rehabilitation projects.

There is an apparent pattern of using this land. On average, one third of commune land is “barren” (90 % due to human activities); a third of barren land is allocated to households. Interestingly, farmers do not at all attempt to reclaim, on average, one third of the allocated land, keeping it rather as a latent asset, counting on subsidies of potential or existing rehabilitation projects in the future. Success rate of the attempted reclamation is less than 50 %, so that households can, during the stipulated period of three years upon allocation, actually utilise only up to a third of the allocated land (mostly for establishing plantation forests and upland crops). Longer-term land cover change analysis at commune level shows that barren land has been the most dynamic category, and, upon reclamation, about 40 % of it is used for, officially not recognised, shifting cultivation.

Keywords: Barren hills, land allocation, land degradation, land rehabilitation, Viet Nam

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Analysis of Land Use Change in the Wild Forest Coffee Systems of Berhan-Kontir and Geba-Dogi in Sheko and Yayu Districts of South-Western Ethiopia

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A formal household survey with samples of 120 respondents each was conducted at Geba-Dogi and Berhan-Kontir montane forest in South-Western Ethiopia to assess the economic value of wild coffee forest populations under a project called Conservation and use of wild Arabica coffee populations in Ethiopia (COCE). The data were analysed using descriptive and econometric techniques. The econometric technique was used to explain a binary attribute of complete conversion of the wild coffee forest plot out of what farmers had ten years ago, and to explain the intensity of land use conversion.

The land use system surrounding both forest zones has been changing such that the area of the forest land with wild coffee populations that are identified to have diverse coffee genetic potential has been decreasing and replaced mainly by a managed form of coffee production. Although institutional factors like increase in coffee price encourages farmers to convert their wild coffee forest land, different household and farm characteristics are associated with farmers' attribute of keeping certain wild coffee forest plots. Most importantly, factors like maize farm size, food shortage, distance from district centre, distance from forest area to residence, settlement history, and the size of improved coffee farm are important.

In such cases where farm land is the only resource on which the households depend for their livelihood, farmers' practice of the conversion of the wild coffee forest land is associated to their demand for additional crop land. Those farmers with a relatively larger cultivated area of maize and coffee have more wild coffee forest plots. Since shortage of farmland is becoming a constraint, as suggested by most farmers, the current intensive change in land use is threatening the wild coffee genetic resource. Measures that improve farm productivity, could lessen the pressure on the forest.

Keywords: Household, land use change, wild coffee

The Implementation of Renewable Energy Resources for Greenhouse Mitigation in Developing Countries: The Case of Biomass

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The global environmental change represents the most contemporary problem urgent to resolve for the surviving of future generations. It threatens all environments and living forms in the earth, changing cropping patterns, biodiversity and economic structures. The question of natural resource consumption, environmental protection and sustainable development, takes an essential importance through the use of bio-energy carriers in worldwide implementation, which could serve like a catalyser in the measures to resolve principally the question of greenhouse effect in widely form.

The elaboration of bio-energetic carriers, according to a bio-energy implementation especially in rural areas, presents a new platform to get sustainable and rural development. This development would grant the idea of living environmental protection, economical growth and nature conservation.

At this base, biomass resources have the potential to mitigate greenhouse effect, giving a neutral energetic raw material in reference to carbon dioxide (main precursor of this phenomenon) and the renewability of the productive cycle. The variability of biomass resources, as a base to produce different bio-energy carriers (liquid, solid and gas bio-fuels), is a way that can be used to replace fossil sources in transport and energy sector principally in rural farms and in country seats of the Developing Countries.

The benefits gained by mean of biomass resource use in the Developing Countries, at base on the implementation of a correct planning and administration for the integration of the bio-energetic systems and programs, would be the rehabilitation of landscape, the reduction of the sulphur oxide, methane and nitrogen emissions to the atmosphere, the constant development of rural industries and employment, breaking the existing economic disparity between cities and rural areas, and at the same time elevating the life standard of rural population.

The present article has like the principal objective to analyse the possibilities to implement renewable energy resources for greenhouse mitigation in the Developing Countries, which in this case are biomass resources and to establish sustainable rural development by the way of bio-energy carrier production.

Keywords: Bio-energy carrier production, bio-energy system implementation, bio-fuels (liquid, solid and gas), carbon mitigation, climate change, environmental problems, rural development, sustainable development

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Land Evaluation of Cotton Production in the Azokan's Catchment in the Moist Savannah of Benin

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Good and appropriate advice to land evaluation and land utilisation requires good knowledge of soil resources and soil fertility. Detailed knowledge about the endowment with land resources and its potential is an essential prerequisite for the sustainable agricultural and economical development of the region. The central region of Benin Republic (West Africa) is characterised by a subhumid tropical climate. During the last two decades, a tremendous change in demographic growth and land use has been observed in this region. In particular, the area with cotton production increased six fold from 1987 to 1997. However, the productivity per hectare decreased. A soil and digital database of Azokan's catchment, which is located in Central Benin, was established to evaluate the ability of land units to support cotton production and to compare the results with cotton yields realised by the farmers.

Soil transects and a topographic map were combined to provide information on spatial variability of soils, terrain type and land use. For the management of soil and terrain data the SOTER (Soil and Terrain Digital Database) approach was used, which includes observations, analytical attribute data and GIS-based spatial terrain data. The FAO/LSC (Land Suitability Classification) was used to identify crop specific constraints to cotton production. The land index of different soils in the study area is marginally suitable to unsuitable. In parallel, farmers were interviewed with respect to their level of knowledge, their farming practices in the cotton fields and the obtained cotton yields in relation to the natural land units. The results show that the low indices are due to both physical and chemical limitation levels (texture and organic carbon). Unfavourable climatic conditions determine the suitability of the region for cotton production. Appropriate management by farmers increases the yield potential significantly. The study reveals that the realisation of higher yield potentials depends on the social and economic position of the farmer.

Keywords: Cotton production, land evaluation, land productivity, subhumid savannah

Characterisation and Classification of Agricultural Land Use Systems in Kakamega, Kenya: Implications on Soil Fertility, Productivity and Biodiversity

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The Kakamega forest in Western Kenya is surrounded by diverse agricultural land use systems, ranging from small-scale subsistence over mixed subsistence and cash cropping, to industrial monocropping systems. The diversity of field, home garden and tree crops and of auxiliary plant species is large but varies both spatially (climate, soil type, market access, forest proximity) and with the production system. A high population growth rate has led to an unprecedented land use intensification and land fragmentation. A low external input use combined with near permanent cropping has resulted locally in severe soil fertility depletion, a reduced production potential and low yields. With declining resource base quality the growing pressure on the forest for land and other resources is posing a threat to its existence. The desired conservation of this forest requires protective policies but also technical options for farmers that increase production and income levels and improve rural livelihood. Any such strategy needs to be based on a quantitative understanding of the changes in land use and resource base quality and their underlying processes and driving forces. In a first step to provide such information and in view of developing land use planning and decision tools, we established a typology of agricultural land and resource use systems. This typology is based on information about demography, climate, soils, crops, productivity and resource management practices as well as the changes in these parameters along biophysical and socioeconomic gradients (agroecological zone, forest proximity, population density). A total of eight administrative units were covered, 159 household interviews were conducted and observations on crop performance and plant diversity were complemented by some 200 soil samples that were analysed for a range of soil quality indicators. Questionnaire data are being analysed using principle component and cluster analyses and the results will be correlated with soil and production data. The identification of distinct clusters of farm and land use types will be used to project future land use changes and to identify pilot farms for the development and testing of site and system specific technology options.

Keywords: Crop production, resource management, soil fertility, typology

Land Use and Cropping Intensity Changes in Western Kenya: Driving Forces and Implications on Resource Base Quality and Rural Welfare

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To meet the rapidly growing food demand and to raise household income, farmers in Kakamega District in Kenya intensify their crop production systems in an unprecedented way. The traditional multiple and mixed cropping systems include field crops (maize and beans), home gardens (indigenous vegetables), fruit and auxiliary tree stands (agroforestry) and the integration of animal husbandry with cultivation of forage species and the application of animal manure. This highly diverse and integrated farming system has been able to sustain yield levels, to minimise risks, and to maintain the resource base quality (soil fertility and biodiversity) at a reasonable level. Nevertheless, it is disappearing and many parts of the district are being displaced by either industrial plantations or subsistence-oriented field gardens. Mono-cropping with maize, sugar cane and tea dominates the agricultural landscape in infra-structurally favoured areas and forest buffer zones. Despite moderate use of external inputs, soil quality indicators suggest occurrence of nutrient depletion and imbalances and a loss of the functional biodiversity. On the other hand, the densely populated rural areas and the peri-urban fringes are increasingly characterised by land fragmentation and the permanent and year-round cultivation of subsistence food crops on land holdings of less than 1 ha. With animal husbandry having been discontinued for lack of land for forage production and crop residues being used for fuel, soil fertility decline and land degradation can be severe. Both production systems appear to threaten the biophysical and socioeconomic sustainability and their emergence patterns need to be understood in order to provide adapted and adoptable alternatives. Analyses of secondary data sources combined with household survey interviews were used to determine the driving forces and the factors influencing the spatial and temporal dynamics of land use and cropping intensity changes and indicators for biodiversity, agricultural productivity, and rural welfare were assessed along biophysical (agro-ecological zone, distance from primary forest) as well as socioeconomic gradients (population density, market access). Surveys and analyses are under way and the results will be discussed.

Keywords: Biodiversity, livelihoods, productivity, trends

Methods of Control and Rehabilitation of *Imperata* Grasslands in Peruvian Amazon

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The region of Ucayali in the Peruvian Amazon is confronted with the problem of the noxious weedy grass *Imperata brasiliensis*. It covers large areas of former rainforest that was replaced by farmland through so-called slash-and-burn farming. After one year of sufficient yields the soil becomes very poor in nutrients and weeds like *I. brasiliensis* appear. The typical method of control of *Imperata* grasslands used by local farmers is to burn the grassy fields to get “clear” land again.

The focus of this pilot study was to develop the most suitable method of suppression of this weedy grass. The trial was set up in the Ucayali region near the city of Pucallpa and biological, mechanical and chemical methods of control were compared. A complete randomised block design with four replications was used. Treatments as shading, herbicide spraying, manual weeding, leguminous cover crop and burning were compared to the control plot. An ANOVA test was conducted to investigate statistical differences in the height of the stems and biomass growth. The samples of height and weight of aboveground (AB) and belowground (BB) biomass was measured every 45 days from the square area of 0.5 per 0.5 m. Shading had statistically lowest values of biomass growth after 225 days (19.3 g AB and 60.8 g BB) while burning reached the highest values (104.6 g AB, 97.6 g BB). Manual weeding and herbicide reached lower values in the beginning but since the 270th day the weight has been growing more rapidly. After burning *Imperata* produces seeds, which enable better spreading to the surrounding area. Leguminous cover crop didn't show any significant effect. From the results we can conclude that the most efficient method of control in the short term is manual weeding and herbicide spraying, but they are the most expensive methods in the meaning of labour or money. In the long term shading out the grass, e.g. through tree growing, could be suitable and efficient method for small farmers in the study area.

Keywords: Biomass growth, *Imperata brasiliensis*, Peruvian Amazon, slash and burn farming, weed control

Modelling of Biomass Dynamics under Grazing Conditions and Regional Water Balance Aspects for the Drâa Catchment in South-Eastern Morocco

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The ecosystem simulation model SAVANNA (Coughenour 1999) is used to represent biomass dynamics under grazing conditions in rangeland landscapes in southern Morocco. This study is embedded in the IMPETUS project (Integratives Management Projekt für einen tragfähigen Umgang mit Süßwasser), an interdisciplinary project of the universities Cologne and Bonn. SAVANNA was calibrated for a characteristic rangeland area of the northern Draa valley at Taoujgalt (1900 m a.s.l.), located at the southern slope of the High Atlas mountains and having a homogeneous plant cover. The dominant perennial species are *Artemisia herba-alba* and *Teucrium mideltense* which were parameterised by transpiration studies and calibrated by biomass determination measurements carried out in the years 2001—2003. For validation of the model, a vegetation specific database with biomass allocation and transpiration rates was created for the local species. Since spring 2004, measurements of biomass and plant growth parameters of species such as *Adenocarpus baquie*, *Hertia maroccana* and *Stipagrostis*, as well as auxiliary soil data round up the SAVANNA database for input parameters and calibration purposes in this area. Explicit animal diet and plant preference data, for sheep, goats and dromedaries, which are the most abundant animals in this area, were provided by pastoralists and zoologists at the OSS/ ORMVAO (Benidir 2005, Ramdane 2005). Biomass withdrawal by trespassing nomadic people and their herds and by human activities sum up to 500 t_{haa} (El Moudden 2005) and are considered for model objectives. Model results indicated an underestimation of root (leaf-) water uptake and reproduction rates for *Artemisia herba-alba*. The consequence is a high mortality rate during the hot summer season. The modelled population density of *Artemisia herba-alba* overestimated real values in spring by 10 % and was 23 % too low in the flowering season in autumn. On the other hand, the seasonal biomass calculated by SAVANNA exceeded observed data values. Further areas within the catchment area, having a long tradition as rangelands for goats, sheep and dromedaries of nomadic people and semi-sedative farmer population will be simulated.

Keywords: Biomass dynamics, grazing, Morocco, pastoralism, Savanna model

Farmer-Herder Conflicts in the Sahel: Causes, Consequences and Starting Points for Conciliation

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Conflicts between farmers and herders are common in the Sahel. At first sight these conflicts seem to be related to the use of land and water resources. With an ongoing encroachment of cropland onto pastures, the feed resources for herders decline. Herders intrude into cropland to acquire forage for their animals. However, scarcity of resources alone is an inadequate explanation for most farmer-herder conflicts. The recurrent droughts of the 1970s and 80s in the Sahelian zone had strong repercussions for farmer-herder relationships. Relationships involving mutual trust, such as manuring and entrustment contracts, were replaced by potentially more confrontational arrangements, such as wage and tenancy contracts. Another direct effect of this change was the increased tendency of farmers to harvest all crop residues and withdraw this resource from the common pool. Herders tried to settle (part of their family) on strategic spots in order to claim land and secure resource access rights. In some cases herders even tried to obtain private rights on wells in order to fully control the surrounding pasture land. Therefore, most conflicts are also shaped by the “political strategies” of the people involved.

Farmer-herder conflicts escalate from time to time sometimes resulting in serious casualties. For this reason, conflict mediation has become a focus for several institutions. This presentation addresses some starting points for mediation of farmer-herder conflicts at different intervention levels, based on the experiences of several development projects and local organisations.

At an (inter)national level, administrative and judiciary institutions should recognise pastoralism as a valuable, ecologically sound production strategy which utilises common natural resources. Equal rights for all populations to access common natural resources should be provided.

At a local and regional level, investing in the social capital and infrastructure is of the utmost importance (e.g. supporting dialogue structures, meeting places, meetings/forums). These investments will encourage dialogue and favour / enable agreements between the populations. Such activities are also required to regulate the interactions between all resource users and to introduce decentralisation processes, which at present are at the implementation phase in many Sahelian countries.

Keywords: Farmer-herder conflicts, conflict mediation, Sahel

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Socio-Economic Impact of Rice-Cum-Fish Culture in Bangladesh

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This study examines the impact of the rice-cum-fish culture and the rice monoculture on the rural households at Muktaghachha Upazila of Mymensingh district, Bangladesh. Five villages were selected for this study. A stratified random sampling technique was followed in this study. Data were collected from 100 farmers of the selected villages through field survey by using pre-designed questionnaire. Activity budgets were calculated and statistical comparisons computed. The benefit-cost ratio was calculated. Multiple regression analysis was used to determine the impact of different independent variables on total household income.

The major findings of the study were that both the rice-cum-fish culture and the rice monoculture were profitable business for the farmers. However, farmers were making about 3 times higher profit from the rice-cum-fish culture than from the rice monoculture. Per hectare, net return of the rice-cum-fish culture and the rice monoculture were Tk 10230.00 and Tk 3593.00, respectively. The rice yield was increased by 11.4 % in the integrated rice-cum-fish culture compared to the rice monoculture. Fish consumption was increased by 14.5 % with the rice-cum-fish culture compared to rice monoculture. Total cost was also increased by about 49 % in the rice-cum-fish culture above the costs in the rice monoculture mainly due to fingerlings purchasing. Human labour employment was increased by 9.4 % in the rice-cum-fish culture compared to the rice monoculture. The study clearly indicates that the rice-cum-fish culture provides greater scope for returns (1.6:1) and employment opportunities (1.1:1) than the rice monoculture. This study also found that the farmers are practising the rice-cum-fish culture technology without using any pesticides, so this system is ecologically sound and environmentally friendly. Although there are some constraints in the rice-cum-fish culture system like diseases, unexplained mortality of fish and so on, farmers are interested in practising this system to improve their socio-economic condition. Government, policy makers and extension workers should encourage the farmers to practice the rice-cum-fish culture system by providing the necessary information and financial assistance.

Keywords: Bangladesh, rice-cum-fish, socio-economics

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Pathological Evaluation to Some Protozoa Infections among Freshwater Fish in Egyptian Aquaculture

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1088 fish (*Oreochromis niloticus*, *O. aureus*, *Tilapia zillii*, *Clarias gariepinus* and *Cyprinus carpio*) were examined from Abbassa farms, Egypt, for internal protozoa during 2001–2003. 67 % of fish were infected with enteric protozoa. The infection rate among *O. niloticus*, *O. aureus*, *T. zillii*, *C. gariepinus* and *C. carpio* was 62, 57, 80, 58 and 50 %, respectively. The highest infection rate was seen in spring (81 %), followed by summer (72 %), autumn (60 %) and winter (48 %).

Eimeria aurati (35.3 %), *E. rutili* (4 %), *E. sp.* (11 %), *Goussia sp.* I (34.2 %), *G. sp.* II (2.6 %), *Cryptosporidium nesorum* (47.2 %), *Myxobolus nkolyaensis* (2.2 %), *M. carassii* (2.2 %), *M. pharyngeus* (9.2 %), *Mixidium lieberkuehni* (1.1 %), *Ceratomyxia drepanosettae* (1.8 %), *Entamoeba molae* (7 %), *Hexamita sp.* (7 %) and *Trypanosoma tilapiae* (0.7 %) were recorded. The incidence of protozoa varied with fish species.

Histopathological results: *E. rutili* induced tubular nephrosis with developmental stages and activation of melanomacrophages. *Goussia sp.* was recovered from the gas-bladder with no lesion. *Myxobolus* induced intestinal mucinous degeneration, melanomacrophages and leukocytes in *Lamina propria*. The lumen contained spores and sloughed epithelium. *C. drepanosettae* induced severe enteritis with focal sloughing, the lumen contained protozoan tissue debris and leukocytes. *E. molae* and *Hexamita* infections induced mild intestinal degeneration with mononuclear and eosinophilic cells. *T. tilapiae* induced vascular lesions, hepato-cellular and hematopoietic alterations. Successful transmission of *Cryptosporidium parvum* and *Balantidium coli* was experimentally done from cattle to *C. gariepinus*. *C. parvum* infection induced intestinal epithelial desquamation with congestion and leukocytic infiltration. Merogony and gamogony were seen attached to intestinal brush border. With *B. coli* infection, trophozoites and cysts were seen in intestinal lumen with minimal mononuclears.

We concluded that protozoa infections are common among freshwater fish, especially in spring where *Eimeria sp.* was the most prevalent infection. The infection was high in *T. zillii* and low in *C. carpio*. Transmission of *C. parvum* and *B. coli* from mammals to fish are possible. These protozoa induced various pathological changes that could interfere with the growth and/or survival of the infected fish. Therefore, protozoa infections in fish should be controlled.

Keywords: Aquaculture, carp, catfish, Egypt, fish, freshwater, histopathology, prevalence, protozoa, season, tilapia

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Pathological Studies on Encysted Metacercariae Infections among Some Freshwater Fish in Egyptian Aquaculture

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Fish may harbour many pathogens especially parasitic diseases which interfere with the aquaculture production and could constitute a zoonotic importance, especially in developing countries. In this study, 200 freshwater fishes (100 *Oreochromis niloticus* and 100 *Clarias gariepinus*) were collected from Abbassa fish farms, Egypt and examined for encysted metacercariae. The prevalence of infection among the two species was 70 and 83 %; respectively and was higher in winter (100 %), than in summer (92 %), spring (60 %) and autumn (28 %) for *O. niloticus* but was same along all seasons (82 %) for *C. gariepinus*. The infection was higher in males (71.4 % and 56.6 %) than females (28.6 % and 43.4 %) for both species; respectively. The common site of infection in *O. niloticus* were the gills (74.3 %) while in *C. gariepinus* was the muscles (97.5 %). There was a positive correlation between the weight as well as length of *O. niloticus* and the infection rate but no correlation was detected in *C. gariepinus*.

The recorded encysted metacercariae were identified either by direct microscopic examination (Heterophylids, Clinostomatids, Euclinostomatids, Prohemistomatids, Cyanodiplostomatids and Diplostomatids) or via experimental infection of chicken and resulted two trematodes (*Prohemistomum vivax*, *Mesostephanus applendiculatus*). The infected fish showed excessive mucus, loss of scale, some respiratory distress and black to orange spots or nodules on the affected organs. Microscopically, the parasitic cyst was seen embedded in the affected organ. Induced pressure atrophy and degenerative changes and maybe necrosis with or without tissue reactions (mononuclear cells, melanomacrophages and/or connective tissue capsule) depending on the period of infection and the nature of the metabolic products of the parasitic cysts. Based on the high incidence of encysted metacercariae in the investigated fish, we recommend further investigations to identify other trematodes especially those of zoonotic importance, enough inspection and/or cooking of fish to destroy metacercariae, control of snails and migratory birds with increasing fish resistance to the infection.

Keywords: Aquaculture, catfish, chicken, Egypt, fish, freshwater, metacercariae, pathology, Tilapia

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Factors Affecting the Spawning Activity in Nile Tilapia — The Influence of Temperature Treatments and Stocking Management

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Unlike other important fish in aquaculture, a suitable tool to induce spawning in the female Nile Tilapia (*Oreochromis niloticus*) in a given period has not been discovered yet. The benefits of a synchronised spawning behaviour would be a considerable saving in labour as well as greater accuracy in the planning of large batches of fry and reduced water requirements. Hormonal treatments are costly and have not brought about satisfactory results due to the asynchronous and aseasonal nature of *O. niloticus* with its short spawning interval. The aim of the present study is to evaluate the effect of temperature regimes and stocking density changes on the spawning activity of *O. niloticus*. In the temperature experiment adult females from the Lake Manzala population, Egypt, were acclimatised in groups of twelve in 300 l glass-aquaria for 1 week at optimum conditions (temperature 27.6°C; pH 6.9). The temperature was then decreased to about 22 °C for 4 weeks, subsequently the temperature was raised to original level again and the fish were observed for a further 1 week. For the stocking density tests the females were taken from a 1m³ basin (stocking density 29–45 kg m⁻³) and placed in the glass-aquaria at optimum conditions in groups of twelve, or individually (stocking densities; 13 and 6.5 kg m⁻³ respectively) and observed for a period of 4 weeks. During all experiments the fish were checked daily for signs of spawning after which they were artificially striped and eggs fertilised. Egg-quality was measured as the percentages of hatchlings after 4 days and swim-up-fry after 9 days. 24 % of females spawned within the first 3 days after temperature treatment compared to 7 % of the control fish. The long cooling period of the females (n=48) seemed to have a negative effect on the egg-quality with hatching and swim-up-fry rates of 25 % and 22 % in average while the control values were 53 % and 48 % respectively. More promising synchronisation came from stocking the females individually without temperature treatment. From 48 experimental breeders, 33 % of females spawned within the first 3 days after stocking, and hatching and swim-up-fry rates were 49 % and 41 % respectively.

Keywords: Aquaculture, *Oreochromis niloticus*, spawning, stocking density, synchronisation, temperature

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Effect of Dietary Phosphorus Concentration on Growth, Feed Utilisation and Body Composition *Labeo rohita* (Ham.) Fingerlings

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Since phosphorus is widely responsible for water pollution, and feed is the ultimate source of this mineral, a feeding trial was conducted to adjust phosphorus concentration in the diet of Indian major carp (*Labeo rohita*) fingerlings for maximal growth. The effect of increasing dietary concentration of phosphorus on feed intake, feed conversion ratio (FCR), protein efficiency ratio (PER) and body composition of *L. rohita* fingerlings was also studied.

Five iso-nitrogenous and iso-caloric diets were prepared using fishmeal, groundnut oil cake, soybean meal, ground maize, oil and a vitamin-mineral mixture free of phosphorus. Sodium di-hydrogen phosphate was added to the basal diets to arrive at phosphorous (P) concentrations 6.8, 9.0, 11.0, 13.1 and 15 g kg⁻¹. Fifteen groups of fingerlings of 20 fish in each group, with mean initial biomass of 135 g, were stocked in each of 150 L cement tanks. Each diet was hand fed to triplicate groups of fingerlings, three times daily, till satiation. At the end of 29 days experimental feeding final biomass in each tank was recorded, fish were killed, homogenized and analysed.

Mean final phosphoreous contents (g P kg⁻¹) and fish biomass were: 6.8 g P, 158 g; 9 g P, 169 g; 11 g P, 185 g; 13.1 g P, 173 g; 15 g P, 163 g. The fish fed with the diet added with 11 g P kg⁻¹ attained the highest ($p < 0.05$) final biomass, so also gained the highest net biomass. Total feed consumption by the groups per unit biomass did not vary significantly ($p > 0.05$) during study. The significantly highest FCR was observed in fish fed on 11 g P, and the lowest FCR was observed in those fed 6.8 g P and 15 g P. The PER value of fish that were fed on diets containing 9.0–13.1 g P was similar, and these values were significantly higher than that of those fed 6.8 and 15 g P. The fingerlings accumulated increasing ($p < 0.05$) total ash as well as P and decreasing lipid ($p < 0.05$) in the whole body composition with increasing dietary P concentration. The broken-line regression analysis indicated that for maximum growth *L. rohita* fingerlings require 11 g P kg⁻¹ dry diet.

Keywords: Body composition, carp, growth, *Labeo rohita*, phosphorus

The First Test Shrimp Culture Results from Izmir — Turkey

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The first test culture of shrimp (*Penaeus semisulcatus* and *Penaeus japonicus*) in earthen ponds was carried out in Izmir, a city near the Aegean Sea in western Turkey. In this experiment, it was aimed at investigating the effects of different regional and climatic conditions on the growth, survival rate and biomass gain of *P. semisulcatus* and *P. japonicus* and compare their results. Experiment took place at a marine fish farm (Pinar Sea Products) located in Ildir-Izmir in 2002. Brood stocks were transferred from Antalya, Turkey, and larvae culture was conducted on the farm. Two rectangular ponds (size 100 m² and water depth 1.2 m) were used. The ponds were stocked at the rate of 15 individuals per m² when the shrimps were 25 days post larval (PL) stage. Prior to stocking, PL quality was tested using morphological and viability characteristics. Starting on the day of stocking, ponds were sampled fortnightly at 7 h and 15 h for temperature (°C), salinity (‰), pH, dissolved oxygen (ppm) and turbidity (cm). The water exchange rates were 0–15 % daily for the two ponds. Shrimp were fed sea bream feed and feeding frequency was changed from 3 to 1 times daily. A yield of 1920 kg ha⁻¹ for *P. semisulcatus* and 516 kg ha⁻¹ for *P. japonicus* was obtained in 150 days of culture with survival rates of 82 % and 59.3 % respectively. At the end of the rearing cycle, average final weights for *P. semisulcatus* and *P. japonicus* were 15.6 g (SD 1.3) and 5.9 g (SD 0.9), respectively.

As a consequence, *P. semisulcatus* seems to be the more suitable species under Izmir conditions as far as growth performance, final yields and survival rates are concerned.

Keywords: *Penaeus japonicus*, *Penaeus semisulcatus*, shrimp culture, Turkey

Induced Spawning of Batfish (*Oreoglanis siamensis*)

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The batfish belongs to the family *Sisoridae* (Sisorid catfishes) and is native to the Mekong and Chao Phraya basins. The species inhabits high mountain streams and feeds on insects and worms. In northern Thailand, the fish was found abundantly in the streams of the mountain area of Doi Inthanon and Doi Chiang Dow, where they hide under the rocks, but nowadays the numbers are decreasing substantially. A restocking programme is planned, however, till now no information is available about artificial reproduction of this species. Therefore 92 fish with an average size of 8.4 cm and an average weight of 5.5 g were collected from streams of the Chiang Dow district in Chiang Mai province. These streams are characterised by a mean water temperature of 18°C, dissolved oxygen of 7 to 11 mg l⁻¹, pH 6.4 to 8.9, water hardness of 19 mg l⁻¹ as CaCO₃, and 2.24 mg l⁻¹ free CO₂. The fish were transported to the Chiang Mai Inland Fisheries Research and Development Center, Department of Fisheries, Chiang Mai, where the fish were kept in aquaria. Male and females could be distinguished clearly only in the spawning season which occurred from February to October. The sex ratio of fish was 1:1.18 male to female. In March, fish were injected with burselin acetate (30 µg kg⁻¹ body weight) and domperidone (10 mg kg⁻¹ body weight) to induce spawning. Brood fish started spawning 24 hours after injection. Stripped eggs were yellow, of round shape and 0.35 cm in nucleus diameter. The incubation period of fertilised eggs was around 240 hours at 18–20°C water temperature with a mean hatching rate of 15%. Newly hatched fry had a total length of 1.05–1.20 cm and a yolk sac diameter of 0.35 cm. The post larval period was 28 days with fry size of 2.1 cm length and 0.065 g weight.

Keywords: Aquaculture, induced spawning, *Oreoglanis siamensis*

Evaluation of Pea Protein Concentrate as Dietary Protein Source for Tilapia (*Oreochromis niloticus*) Fingerlings

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A feeding trial was conducted to evaluate the effect of fish meal replacement by pea (*Pisum sativum*) protein concentrate on the growth performance of Tilapia (*Oreochromis niloticus*) fingerlings (initial weight: 2.3 g \pm 0.08 g). Four feeding groups were fed with isonitrogenous diets (crude protein: 42.3 % \pm 0.3 in dry matter) varying only in their protein sources for 56 days at a level of 5 % biomass/d. Fish meal based protein content of experimental diets was substituted with 0 % (diet 1 = control group), 30 % (diet 2), 45 % (diet 3) and 60 % (diet 4) pea protein. Performance test of Tilapia fingerling was assessed by comparison of weight gain (WG), specific growth rate (SGR) and feed conversion ratio (FCR). The feeding groups (in triplicate) were reared in the tanks of two similar recirculation units

Highest individual weight gain (21.4 g \pm 0.78 g) and SGR (4.2%/d \pm 0.11%/d) was observed in Tilapia fed diet 1, followed by fish fed diet 2 (19.1 g \pm 0.63 g; 4.0 %/d \pm 0.02 %/d), diet 3 (16.7 g \pm 1.30 g; 3.8 %/d \pm 0.11 %/d) and diet 4 (16.2 g \pm 0.25 g; 3.7 %/d \pm 0.04 %/d).

Furthermore, feed conversion was most efficient in fish fed diet 1 (0.9 \pm 0.04) compared to diet 2 (1.0 \pm 0.01), diet 3 (1.1 \pm 0.03) and diet 4 (1.1 \pm 0.01). Although, fish fed diet 1 (containing 100 % fish meal protein) showed best performance, inclusion of 30 % pea concentrate protein resulted in growth rates, which did not differ significantly from diet 1. Feeding Tilapia fingerlings with higher amounts of pea protein concentrate (45 % or 60 % pea protein) yielded in lower growth without significant differences between each other. The results suggest that it is possible to replace up to 30 % of fish meal protein without adverse effects on fish performance. Nevertheless, higher amounts of pea concentrate led to decreased but still sufficient growth of Tilapia fingerlings.

Keywords: Fish meal replacement, growth performance, pea protein, tilapia

Investigations on the Nutrient and Antinutrient Content of Typical Plant Ingredients Used as Fish Feed in Small Scale Aquaculture in Yen Chau, Son La Province, Northern Viet Nam

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In Yen Chau, Son La Province in Northern Viet Nam, fish farming is a commonly practised activity. In that region the aquaculture products significantly contribute to the supply of animal protein to households. The main cultured fish species in this region is grass carp, which is usually produced in polyculture together with common carp, mud carp, silver carp, silver barb and tilapia. The culture system which prevails here can be classified as semi-intensive.

Plant leaves are the main feed input to the ponds in small-scale fish farming in Yen Chau where the farmers normally feed crop residues, such as leaves from cassava (*Manihot esculenta*), banana (*Musa nana*), maize (*Zea mays*) and bamboo plants. Different grasses and duckweed, both collected from the paddy fields, as well as rice bran and cassava peels are also frequently fed to fish. So far, the nutritional potential of these plant feeds for fish has not been investigated.

Samples of feed items commonly used over the year by six representative fish farmers in Yen Chau were regularly collected and analysed for their chemical composition. Crude protein, fat, moisture, ash, crude fibre and neutral detergent fibre (NDF) content were measured. The gross energy content, as well as the content of antinutrients, such as phenolic substances, tannin, saponin, trypsin inhibitors, cyanogens, and phytase were also determined. The aim of the study was to assess the suitability of these plant ingredients as fish feed and evaluate any possible temporal changes in their nutrient, energy and antinutrient contents during the course of the year.

The results of this study will allow us to get a better understanding of the nutritional quality of the collected plant materials as fish feed. The results of the ongoing analyses will be presented in the full paper.

Keywords: Antinutrient, fish feed, plant composition

Differential Treatment of Non-Toxic *Jatropha curcas* L. and its Impact on Growth Performance and Whole Body Mineral Absorption of Common Carp, *Cyprinus carpio* L.

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Jatropha curcas L. is a drought resistant tree widespread throughout the tropics and subtropics with seeds rich in oil and protein. This plant has significant economic importance because of its agro-industrial and medicinal uses. This study was conducted to evaluate the suitability of non-toxic *J. curcas* as an alternative protein source for common carp, *Cyprinus carpio* L. Four experimental diets were formulated to contain defatted and heat treated non-toxic *J. curcas* at 50 % of total dietary protein (Diets Jat, J-Eth, J-Lys, J-Phy, respectively) with one further diet acting as a control (Diet Con) which included only fish meal and wheat meal as protein sources. The defatted and heat treated jatropha in the experimental diets was either extracted further with 80 % ethanol (Diet J-Eth), supplemented with 1 % L-Lysine (Diet J-Lys) or had 500 FTU phytase added (Diet J-Phy). All the diets were isonitrogenous (37 % crude protein) and isoenergetic (19.5 kJ g⁻¹). A 52 day feeding trial was carried out on two replicate groups of six fish (initial weight ca. 6g) per treatment. Fish were given seven times maintenance at 25°C. The addition of L-lysine or phytase raised the percentage body weight gain to levels comparable to the control whereas fish fed Jat or J-Eth showed significantly lower performance. There were no significant differences in feed intake, food conversion efficiency, protein efficiency ratio, protein productive value and energy retention among the fish receiving the experimental diets. Generally, all the diets containing jatropha decreased body moisture content and raised lipid with the highest value recorded in the J-Eth group. Ash was significantly lower in Diet J-Eth when compared to the control. Whole body P and Mg were significantly higher in J-Phy comparable to control, whereas, K and Ca were significantly lower only in group J-Lys. There were no significant differences in Mn, Fe and Na among the groups, but the level of these minerals was slightly higher in group J-Phy, which thus came closer to the control than the other experimental groups. This study shows that non-toxic jatropha is a very promising source of cheap plant protein for common carp when properly treated before diet formulation.

Keywords: Common carp, non-toxic *Jatropha curcas*, protein source

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Comparative Efficiency of Apparent Protein, Lipid and Dry Matter Digestion of a Laboratory Feed in Three Strains of Nile Tilapia, *Oreochromis Niloticus* (L.)

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East and Southeast Asian countries contribute more than half of the global tilapia production of above 2 million metric tons. The GIFT (Genetically Improved Farmed Tilapia) and GMNT (Genetically Male Nile Tilapia) strains of Nile tilapia (*Oreochromis niloticus*) have been introduced in many of these countries with the primary aim of enhancing the growth performance of farmed tilapia. The claimed higher growth performance of GIFT might be due to more efficient digestion of their food, higher survival rates or delayed sexual maturation. To investigate the comparative digestion efficiency of protein, lipid and dry matter in a laboratory feed (41 % crude protein and 9 % crude lipid), an experiment was conducted with three strains of Nile tilapia namely, sex reversed GIFT (GIFT: $52 \pm 6.3\text{g}$), genetically male (GMNT: $46 \pm 4.2\text{g}$) and non-sex reversed conventional (CNT: $50 \pm 5.1\text{g}$). Experimental strains were reared individually in a recirculation system at a water temperature of 27°C in 50 l glass aquaria for 10 weeks. Laboratory feed with an inert marker, titanium dioxide (TiO₂), was used to measure the apparent digestibility of protein, lipid and dry matter for the experimental tilapia strains. Feces of individual fish were collected daily by siphoning during 8 weeks of feeding trials and pooled samples from each week were analyzed. At the end of the experiment, there were no significance differences ($p < 0.05$) in individual growth development, specific and metabolic growth rates, or feed conversion efficiency between the three tilapia strains. Preliminary results indicate that feed dry matter, protein and lipid digestibility between the three strains did not show significant differences ($p < 0.05$). We conclude that the three experimental tilapia strains did not differ significantly in the efficiency with which they digested the ingredients of their feed under laboratory scale experimental conditions. The results of the present experiment would be useful in providing some indications to fish farmers in tropical and subtropical regions on the efficiency of the improved strains (i.e., GIFT or GMNT) compared to conventional strains of Nile tilapia.

Keywords: Digestibility, genetically improved farmed tilapia, genetically male Nile tilapia, Nile tilapia (*Oreochromis niloticus*), titanium dioxide (TiO₂)

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The Use of Pesticides in Paddy Rice and Possible Impacts on Fish Farming in Yen Chau/Son La Province, Northern Viet Nam

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Within the framework of the Special Research Program “Sustainable land use and rural development in mountainous regions of Southeast Asia” a survey was carried-out in order to describe and assess interactions between paddy fields and fish ponds in Yen Chau district, Son La province (Northern Viet Nam). In the research area paddy fields and fish ponds are closely linked to each other, e.g. by a common irrigation system, which leads water from paddy fields into ponds and vice versa. Frequently occurring mortalities of grass carp (as main fish species in the pond system) lead to the assumption that certain activities carried-out in the paddy fields (e.g. use of pesticides) influence fish health in ponds. In this research the two systems “paddy field” and “fish pond” with all their interrelations are described and it is assessed, whether pesticides might have been the causative factor for the occurrence of grass carp mortalities.

Wholesalers and retailers for agricultural inputs as well as 30 farmers in Yen Chau were interviewed on pesticide availability, indications for their use and application practices in order to estimate their potential impact on the aquaculture system.

Many pesticides used in the region are classified as moderately to highly hazardous according to WHO (World Health Organisation). Even though farmers usually stop the water flow after application of pesticides for one or more days, pesticides may still reach ponds in case of leaching and heavy precipitation. Also by-products from paddy fields, which are used as fish feed (e.g. weeds), may carry pesticides into the pond system.

It is not very likely that the application of pesticides directly correlates with grass carp mortalities in Yen Chau ponds, as mortalities also occur in times when no pesticides are applied. However, pesticides enter ponds by the water flow and/or by feeding of paddy field by-products and they probably contribute to a chronic stress of fish and thereby make them more prone to diseases.

Keywords: Fish production, Integrated Pest Management, paddy rice, pesticides, Viet Nam

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Integrated Freshwater Aquaculture, Crop and Animal Production in the Mekong Delta, Viet Nam: Participatory Assessment of Current Situation and Opportunities for Sustainable Development

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Participatory Community Appraisals carried out during 2001 and 2002 in the central part of the Mekong Delta aimed to understand practices of the integrated agriculture-aquaculture farming systems (IAAS), giving special attention to the contribution of the aquaculture component to household livelihoods, and to identify issues for further improvements and development of IAAS in general and integrated aquaculture in particular. Within the target area, three representative sub-areas were identified and in each sub-area an indicative community was selected for the participatory study. Integrated aquaculture farming was very diverse. Important factors influencing patterns of integrated aquaculture were: bio-physical setting, market accessibility, households' resources and livelihood options. Three common integrated aquaculture system types in the study areas were: (1) low-input fish — intensive fruit farming system, (2) medium-input fish — semi-intensive fruit — animal farming system, and (3) high-input fish — extensive fruit farming system. The first system was characterised by its links with fertile soils, low monsoon flood levels and intensive fruit production was perceived to be a major component, while the second and third systems were characterised by their links with less fertile soils, medium or high monsoon flood levels and less intensive fruit production. Integrated aquaculture was assessed to normally be dominated by medium and better-off households with more land, more labour, capital and experience. Better-off households usually operated their systems on a larger scale and/or attempted some levels of intensification. The high-input fish farming system was common in peri-urban areas, where markets for aquaculture inputs and outputs exist. Compared to low- or medium-input fish farming, intra-farm bio-resource flows were less important within high-input fish culture, the production system being based mainly on off-farm nutrients. Improving nutrient linkages between the ponds and the terrestrial components was identified as an important objective to improve systems (1) and (2) while more nutrient recycling to minimise pond nutrient discharge was an important option for (3). Sustainable development of small-scale integrated aquaculture systems needs a holistic and participatory approach, from which bio-physical and socio-economic factors at farm, community and regional levels need to be taken into account.

Keywords: Integrated aquaculture, nutrient recycling, participatory appraisal, Viet Nam

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Perception and Management of Water Resources in a Changing Tropical Rainforest Margin of Central Sulawesi, Indonesia

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Water as an essential common pool resource is more and more focused in different disciplines around the world. As a part of the ecosystem and a resource for human nutrition water plays a major role in societies' organisation and land use strategies, even in humid tropical zones. Therefore further knowledge about utilisation, perception and management of water is indispensable to a broader understanding of the cultural and natural landscape as a complex system.

Quantitative and qualitative interviews were conducted in selected households of two sample villages. The main focus of the household interviews was on the perception, use and management of water. The expert interviews had a focus on an external view of intervening parties. This combination allows for a reliable interpretation of the data.

Perception: It is important to note that deforestation and land use are seen by the respondents as a main reason of changes in water quantity and quality. Deforestation is perceived as a direct cause of decreasing availability of water. This perception of the local people differs from results of natural sciences because the precipitation and runoff water measurements do not show the same correlation to deforestation processes as perceived in the region. Anyhow, deforestation is, in general, increasing the runoff. Other perceptions conform to natural sciences' outcomes, for example increasing dirt in the water due to erosion in consequence of higher precipitation.

Management: Furthermore the findings show revealing differences between the two villages in water management structures. The main reasons for these differences can be put down to the factors migration and population growth as well as to external intervention (e.g. community development programme of CARE). In addition, differing spatial structures of water supply can be found within both villages, showing clear differences due to the households' location. There are for example great differences in the households' applied technologies (e.g. in the pipe material), though the same sources are used. The explanation for these differences originates in the individual households' socio-economic status.

Keywords: Common pool resources, Indonesia, perception, tropical rainforest, water management

Socio-Economic Study on Wastewater Management and Ecosanitation in Integrated Farming Systems of the Mekong Delta, Viet Nam

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In the developing world the growing population faces a broad range of problems in providing water supply, food security as well as waste management. Viet Nam's recent development in agricultural and industrial production leads to increasing pollution of surface, ground and coastal waters. Generally, animal manure is discharged uncontrolled into fields and rivers. The reuse of waste/wastewater for agriculture may be a low cost solution in water treatment and at the same time a significant contribution to food production. This study was born during the course of the SANSED-Project, an interdisciplinary cooperation between the Universities of Can Tho, Bonn and Bochum. The SANSED's objective was to identify criteria for a sustainable wastewater treatment system in the Mekong Delta that allows using animal and human faeces for agriculture production in a hygienic, economic and ecological appropriate way. Within this scope a socio-economic study analysed and evaluated the acceptance of new technologies applied in the field of biogas technology and ecological sanitation on the operating farm household level (OFH). By means of a detailed questionnaire, the survey aimed to achieve information about the OFHs' environment and interactions in three selected communities. The key objective was to analyse the OFHs' attitudes and acceptance behaviour of biogas plants (BGP), modern latrines (ML) and biogas sludge (BGS) as principal components of an ecological wastewater management system. Referring to the latter, particularly the use of human faeces in the biogas technology was a major point of interest. Within the stratified, disproportional sample 218 OFHs as well as representatives of the local government, universities and other institutions were interviewed.

The study's results present detailed information about the OFHs socio-economic environment, information flows, attitudes towards and acceptance determinants for investment and use regarding each innovation. Therefore, recommendations on implementation strategies are formulated to improve the innovations' acceptance and dissemination rates in a consecutive project.

Keywords: Biogas, extension service, microfinance, sanitation, Viet Nam, water management

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Water Saving Potentials with TDR Measurements

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The water saving potential of moisture detection is obvious for the different applications of irrigation. Under arid and tropic conditions, irrigation farming is facing a relentless conflict of water use interests. On one hand, irrigation water is essential for food security on the other it is bitterly requested by urban basic supply.

The instant measurement of the prevailing water content gives a hand, dealing with arguments of water waste in irrigation farming. The application of moisture sensors contains vast possibilities of controlling and setting irrigation strategies and techniques as well as detecting a deep percolation of irrigation water. But the test value has to be guaranteed reliable, to draw an accurate picture of the current site specific moisture.

For that reason, the Time Domain Reflectometry (TDR) was examined on its accuracy under diverse artificial scenarios, in order to represent worst cases on field. The approach focused on the deformation of TDR probes and the contortion of the measuring volume. The results showed, that large air pores did not effect the signals accuracy at all. However an inferior soil-probe contact undervalued significantly up to 7 % volumetric water content. A deformation of the sensor fork with up to 90° did not significantly effect the quality of the TDR reading, as long as the sensor-soil contact was ensured. Straddling the sensor rods showed a contrary effect with an underestimation of about 5 %.

For the trustworthy application in irrigation practice, there are two opportunities presenting. The direct control of a predestined water content within the root zone of the plant presuppose the knowledge of a suitable water content for the regarded plants. The detection of deep percolation losses is characterised by the sensor placement underneath the root zone. It serves as an emergency break of irrigation.

Keywords: Accuracy, contortion, deformation, moisture detection, TDR, water saving potentials

Soil Type Influence on Calibration of Soil Moisture Detection

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As the detection of soil moisture plays an increasing role in tropical and subtropical farming systems, the reference tool is demanded to be an easy and reliable technique. TRIME (Time Domain Reflectometry with Intelligent Microelements), a further evolutionary stage of the Time Domain Reflectometry provides a display reading, expressing soil moisture in vol. % units. Therefore the moisture gauge becomes an key factor of sustainable irrigation farming and resource protection.

In contrast to conventional TDR (Time Domain Reflectometry) it is superfluous, to read the characteristic TDR curve and derive the signal length, which represents the runtime of the electromagnetic wave within the surrounding soil. Moreover the bulk density of the regarding soil has to been known, in order to translate the TDR reading into a value of volumetric water content.

TRIME is providing a basic calibration, which enables the system to read convenient values on most soils. The system is limited at locations with a higher content of organic matter and therefore a higher salinity of the substrate. For this case, a fresh calibration has to be saved within the handheld device, in order to guarantee a satisfactory test value.

Without any information of the prevailing soil characteristics, it seems impossible, to gain a satisfactory reading of a pre-calibrated system. For homogeneous sites, one calibration fulfils the demand. Heterogeneous sites appear to be the systems final limitation. A research approach of agricultural engineering at the University of Hohenheim is analysing the influences of different soil types on the accuracy of the TRIME reading. For the soil types, to be calibrated per one site, calibration switches are intended to be implemented in the existing gauge. The high tech variation is to contain a GPS (Global Positioning System), which is planned to give access to a soil characteristics database and relate the detected values of the site to the issued data for calibration purposes. The innovative method is expected to improve site specific data and therefore gives a great potential to save valuable and irreplaceable water.

Keywords: Calibration, GPS (Global Positioning System), soil type dependency, Time Domain Reflectometry (TDR)

Measures for a Sustainable Drinking Water Supply in the Rural Areas of the Mekong Delta

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Although, water is omnipresent in the Mekong Delta, the drinking water supply is - especially in the rural areas - still an unsolved challenge. Surface water is polluted by agrochemicals, domestic and industrial waste water. In some areas ground water can not be used for the drinking water supply because of a high salt- and iron content. Furthermore, a continuous decrease of the ground water table can be observed over the last few years. Due to the tropical climate, rain water is only available over the rainy season. Storing rain water requires ideal hygienically conditions which are not always given. Also, existing drinking water treatment plants are designed after one scheme and they do not consider the quality of the raw water.

For two exemplary study sites in the rural area of the Mekong Delta measures for the improvement of the drinking water supply situation are formulated. At first, fundamental data was collected and various field investigations (e.g. water sampling, hydro-geological tests) were carried out. Because of diverse conditions of the two study sites, different concepts for the improvement of the drinking water supply are necessary. Both concepts consider the three dimensions of sustainability; that includes the improvement of the drinking water quality and the hygienic conditions, the minimisation of the investments costs and operating costs and the moderate use of the water resources and the minimisation of the waste water disposals into the water bodies.

As a first step, the installation of rain water harvesting facilities is recommended and the direct inflow of untreated waste water should be minimised at both study sites. At the first study site the improvement of an existing ground water treatment plant is recommended. To lower costs and to optimise the water quality an adjustment of the treatment scheme to the raw water quality is required. For the second study site the construction of a surface water treatment plant is suggested. Here, due to a high suspended solid flux a pret-treatment is needed.

Keywords: Mekong Delta, rural water supply, sustainability, Viet Nam

Consumers' Attitude and Farmers' Situation with Regard to Agricultural Production with Treated Wastewater in the Northern Gaza Strip

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The use of recycled water in agriculture is a crucial element within the framework of integrated water resources management (IWRM) in water-scarce areas, since agriculture consumes the major share of freshwater and thus provides the largest potential for replacing freshwater. This situation holds also for the Gaza Strip, where the prospect of new political and administrative realities nourishes expectations of a new set-up in water resources management in the near future. Changes in water distribution and use are likely to cause changes in agricultural production and the socio-economic carrying capacity of the agricultural sector. A hitherto little known element in the equations is the attitude of producers and consumers towards the use of recycled water. Opinion polls on this subject were carried out in Gaza city and the northern part of the Gaza strip in 2004. The results allowed for a conjoint analysis on characteristics of agricultural products that determine consumers' purchase decisions and the identification of farming systems that are likely to be most affected. Results showed that irrigation water quality has a significant impact on consumers' decision-making irrespective of the type and preparation of products for human consumption. This holds in particular in consumer layers with higher incomes and a comparable high degree of education. Labelling of products with regard to their origin is thus a promising approach for diversified marketing and a potential tool for improving farmers' economic success and the related socio-economic carrying capacity of rural areas. Changing qualities of irrigation water will affect in the first place farming systems that rely predominantly on annual crops since the concerned families depend on their farm income to a much higher degree than families with a significant share of perennial operations in their farm component. The applied methodology allowed for the quantification of these effects and thus contributed operational knowledge to the ex-ante modelling towards impact analyses of effects from potential alternatives in the future organisation of water management in the Gaza Strip.

Keywords: Conjoint analysis, consumers' preferences , farming systems, integrated water resource management, marketing, treated wastewater

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Evaluation of Water Saving Potentials in Lychee Production with Different Irrigation Practices

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Lychee production is becoming more and more prominent in the northern highlands of Thailand. The increasing water demands in dry season led in the past to water conflicts between highland and lowland farmers. Therefore, focus was set on improving lychee irrigation efficiency in the framework of the Uplands Program (SFB 564, University of Hohenheim).

Within the first field campaigns, potentials for improving irrigation efficiency were identified. Besides a better system maintaining, a more site adapted irrigation scheduling as well as site adapted irrigation techniques were proposed. In addition it could be impressively shown, that Time Domain Reflectometry (TDR) controlled irrigation might reduce water consumption up to 80 %.

Based on these findings, the ongoing research sets emphasis on TDR controlled micro irrigation using conventional low-pressure sprinklers as well as pressure compensating drippers and micro-sprinklers.

The objective of the present study is to evaluate the water saving potentials of the three irrigation practices mentioned above by soil water balance modelling with the Hydrus 2D programme. Since potential evaporation under the trees was found to be half of that aside, irrigation is assumed to be applied under the tree crown only. Water content is monitored in 30 cm depth, in which a pressure head of $h=-450$ cm is set as threshold for initializing irrigation.

As upper boundary condition, precipitation is set equal to zero. Averaged E_{pot} and T_{pot} values of dry season 2002 are assumed to recur every day. The hydraulic properties are taken from (Spohrer et al. 2005). Modelling time is set to 50 days.

Water input and water losses by evaporation, transpiration and seepage will be balanced at the end of the modelling time. Thus, the efficiency of the different irrigation practices can be compared to each other. Further on, the results shall help to identify possible weaknesses of the different irrigation practices, which will in turn help to support current research activities.

Keywords: Irrigation, water balance modelling

Investigation and Simulation of the Effective Anisotropy in Hillslope Soil in Northern Thailand

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Application of the agrochemical by farmers in the mountainous regions of Northern Thailand resulted in increased pollution of water sources. To understand and predict the movement of agrochemicals in the soil, the knowledge about the anisotropy of the hydraulic conductivity is essential. Major factors affecting the anisotropy are layered heterogeneity of soil and moisture content variations. Major aim of this study is to investigate the anisotropy in the soil by tracer movement and to model the effect on water and solute transport with the model Hydrus2D. The solute transport study will be carried out on plot scale (2 m × 2 m). Two ideal tracers (NaCl and KBr) will be applied at two different rates of irrigation (10 and 20 mm d⁻¹). Water content and suction will be measured with Time-Domain-Reflectometry probes and Tensiometers at different slope positions and depths from 10 cm to 100 cm. Twenty to twenty-five days after the tracer application soil samples will be collected from different depths and positions and will be analysed for their salt concentration. The orientation of the tracer plume along with the head measurements will be used for calculating the effective anisotropy of the hydraulic conductivity of the soil. These results will be used to calibrate the model Hydrus2D with the purpose to predict the movement of tracer in the soil.

This study will help to understand the effect of anisotropy on solute transport in the soil of the study area. Furthermore, it will show if it is possible to enhance the modelling results by including of hydraulic anisotropy.

Keywords: Anisotropy, hillslope, hydraulic conductivity, solute transport, Time-Domain-Reflectometry, tensiometers

Trade Offs of Using Treated Wastewater in Irrigated Agriculture - The Case of Gaza Strip

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Ground water is the main water source in Gaza strip, but its quality and quantity of groundwater deteriorates. The use of treated wastewater in irrigated agriculture could be an option to cover the increasing water demand. This study aims to assess the potentials of using treated wastewater in the different sectors of water consumption.

The study focuses in particular on the use of treated wastewater for irrigation within the framework of an integrated water resources management (IWRM). A first element in the integration scheme is domestic and industrial water use and its impact on water pricing strategies and the quality and quantity of effluents. The second element is the treatment plant and its required investments, operational costs, water prices and the quantity and quality of gained irrigation water. The third element is the farming population and their level of acceptance to use treated wastewater in different farming systems and the impact on the farming population's livelihood. The fourth element is the reaction of consumers with regard to their acceptance of agricultural products from irrigation with recycled water and, vice versa, their willingness to pay for products labelled as produced with freshwater only. Methodological approaches to the first two elements are descriptive analyses of secondary data, to the third element the Farming Systems Approach and to the fourth element a Conjoint Analysis of determinants for consumers' decision making. Expected results are the determination of the optimal socio-economic distribution of treated wastewater and the spatial display of the corresponding water fluxes..

First empirical results on the social acceptance of treated wastewater use for irrigation show (1) that farmers, who rely on annual crops, show a lower level of acceptance compared to those with perennial crops and (2) that consumers with higher incomes and better education show—as expected—a significantly higher willingness to pay for labelled products and that this willingness decreases in relation to the family income.

Keywords: Conjoint analysis, Farming system, integrated water resource management, recycled water, , treated wastewater

Shifting the Focus of Research on Water Resources Management from Natural to Socio-Economic Watersheds — The Conceptual Framework of a Research Network on Water Questions in the Jordan Valley

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Infrastructure for the transport, distribution and recycling of water has for a long time changed the sphere of influence of decisions on water resources management from natural watersheds to larger social and economic entities. This holds also for the Jordan Valley, where substantial amounts of the natural influx of freshwater is diverted to urban areas outside of the valley and to which even larger amounts of wastewater are channelled in return. Simultaneously, the concept of virtual water gains a new dimension due to repercussions from water quality on the pricing and sales potential of products from irrigated agriculture in remote markets. Water-related linkages within socio-economic watersheds go, however, even further than that. Particularly in water scarce regions water availability and its distribution in terms of quantity and quality between economic and ecological sectors influence a range of parameters that constitute cornerstones of the spatial, socio-economic carrying capacity. Prominent among those parameters are production and employment opportunities, impacts on markets of inputs and products, land use options and the costs of infrastructures. Effects range from changes in the living standard of families up to minimally required farm sizes, potential disturbances of ecological systems and demographic shifts between urban and rural areas. Results from the research of a network of local and German socio-economists, which were published amongst others on the German Tropical Days since 2002, laid the empirical basis for the enlargement of the underlying research concept. Agriculture and farming systems are considered as elements of rural systems, which constitute, together with related peri-urban and urban areas a socio-economic watershed. The obtained state of knowledge also allows for a more precise specification of missing knowledge from other research disciplines, such as e.g. natural and political scientists. The already started interfaces of the socio-economic research network with partners from other disciplines target on further improvements of scenarios for impact analyses of political and policy options in water resources development.

Keywords: Integrated water resource management, Jordan Valley, socio-economic watershed

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Comparison of the Salt Tolerance of the Two Under-Utilised Fruit Species, Baobab (*Adansonia digitata* L.) and Tamarind (*Tamarindus indica* L.)

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Dryland salinity is a common feature in Sudan. However, very little is known about the salt tolerance of *Adansonia digitata* and *Tamarindus indica*. For this reason an experiment was carried out to investigate the physiological response to salinity.

Seeds of *A. digitata* and *T. indica* were obtained from a wild stand in eastern Sudan. Three weeks after germination, 50 seedlings of each species were selected for uniformity and planted in 2.5 l containers filled with quartz sand. Treatments were prepared by adding 20, 40, 60 and 80 mM NaCl to a common nutrient solution. The seedlings were organised in a random block design with 10 replicates per treatment. In the first 10 weeks seedlings received 100 ml every second day and in the last 10 weeks seedlings received 100 ml per day.

In all salt treatments, baobab leaves showed severe injury symptoms. In the tamarind seedlings only 60 and 80 mM NaCl resulted in leaf injuries (chlorosis). Within the 20-week treatment period, there was a remarkable defoliation in the salt-stressed baobab plants. In the tamarind seedlings, there was only a slight defoliation of leaves with considerable leaf chlorosis in the 60 and 80 mM treatment. Reduction of dry weight by the salt treatments was much higher in baobab seedlings than in tamarind seedlings. In baobab seedlings a reduction of 50% of dry weight occurred in the 20 mM treatment. However, in tamarind seedlings in the 20 and 40 mM NaCl variant, the reduction of dry weight was less than 50% after the 20 weeks in comparison to the control plants. Both species accumulated a high amount of Na⁺ and Cl⁻ in the leaf tissue compared to other fruit species.

In conclusion, our results indicate that baobab (*A. digitata*) in the seedling stage can be characterised as a very salt-sensitive tree similar to Citrus species (*Citrus* spp.) and Avocado (*Persea americana*). However, tamarind (*T. indica*) in the seedling stage is a moderate salt tolerant fruit tree species similar to Guava (*Psidium guajava*).

Keywords: *Adansonia digitata*, baobab, growth, ion distribution, salinity, tamarind, *Tamarindus indica*

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Ion Distribution and Partitioning of Date Palm (*Phoenix dactylifera* L.) under Salinity Conditions

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In Saudi Arabia the cultivated area is continuously declining due to many environmental hazards, particularly salinity. The estimated data show an approximately 12000 hectares of cultivated land left in Al-Hassa region. Salinity has been recognised as a major agriculture problem in arid and semi-arid regions. Almost 1/3 of the world wide irrigated land is subject to salinity hazards. About three-quarters of the irrigated land is presently in the developing countries. Salt salinity affects plant physiology through changes of water and ionic status in the cell due to excessive accumulation of Na and Cl and reduces the uptake of other minerals. The increasing water demand and the shortage of good quality resources in arid and semi-arid areas justify the present interest in the reuse of drainage water and treated waste water. Many crops respond differently to salinity. Date palm is the major crop in the kingdom of Saudi Arabia, and it is known to be among the most tolerant crops to salinity. Information on the reduction of date palm development due to salt effects are meagre. This study was conducted at the Kingdom of Saudi Arabia to determine the ionic response of date palm to saline conditions. NaCl as the dominant “soil and water” salt in the Kingdom of Saudi Arabia was used as a source of salinity at different levels, namely: 0, 50, 100, 200 and 400 mM. Three-year-old offshoot of three major commercial date palm cultivars (Khalas, Majdool and Barhee) were used.

Ionic distribution and interaction in the different plant parts was determined, the mechanism of salt tolerance in date palm cultivars through ionic distribution was postulated .

Keywords: Date palm, salinity, ion distribution, Saudi Arabia

Strategies of the Cashcrop Halophyte *Aster tripolium* to Survive at Saline Habitats under Ambient and Elevated CO₂

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About 7 % of the world's total land area and 19.5 % of the irrigated arable land are affected by salt. This leads to desertification, freshwater scarcity and to growth conditions unacceptable for most conventional crops. These problems "threaten the livelihood of over one billion people in more than 110 countries around the world" (KOFI ANNAN) and are even reinforced by global climate change due to rising atmospheric CO₂-concentrations. Halophytes are likely to benefit from elevated [CO₂] because one major constraint for plant growth in saline habitats is the restriction of CO₂-uptake. The sustainable use of cashcrop halophytes such as *Aster tripolium*, a vegetable and ornamental plant, can counteract the problems mentioned above.

Against this background, our study was aimed at obtaining detailed and reproducible information about the combined effects of NaCl-salinity and elevated [CO₂] on *A. tripolium*. Plants were irrigated with five different salinity levels (0 %, 25 %, 50 %, 75 % and 100 % seawater) in a quick-check-system in open-top chambers under ambient (ca. 370 ppm) and elevated (520 ppm) CO₂. The effects of the four major constraints of salinity on plant growth (water relations, gas exchange, ion toxicity and nutrient imbalance) were studied.

Salinity caused a reduction of net photosynthetic rate and therefore of growth and an osmotic adjustment, mainly due to Na⁺- and Cl⁻-accumulation. Furthermore, the abundance of several proteins increased or decreased, respectively, and leaf anatomy and ultrastructure changed. Elevated CO₂ led to a distinct increase in net photosynthetic rate and water use efficiency which, however, was not employed for producing more biomass. Instead, the investment in salt resistance mechanisms was increased: We found a higher content of compatible solutes and an enhanced expression of certain proteins, leading to a higher survival rate.

The results show that *A. tripolium* is a promising cash crop halophyte. It allows the use of saline irrigation water and the reclamation of saline soils, and its sustainable use can help feeding the growing world population. Additionally, on the one hand *Aster* will clearly benefit from rising CO₂-concentrations in future, but on the other hand it can counter global climate change by sequestering CO₂.

Keywords: *Aster tripolium*, elevated CO₂, gas exchange, NaCl-salinity, sustainable use, water relations

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Salt Tolerance of Ethiopian *Phaseolus vulgaris* L. Varieties

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Phaseolus vulgaris L., a staple food crop in Ethiopia, is characterised by a very low salt (NaCl) tolerance. To overcome salt injury, adequate agricultural (e.g. irrigation) methods must be applied, and only salt tolerant varieties should be cultivated by farmers.

In Mitscherlich pot experiments, we tested 10 Ethiopian *P. vulgaris* varieties from the Hararghe region in Ethiopia and 4 modern German varieties obtained from the Bundessortenamt in Hannover by an addition of salt corresponding to an ECe of 0 and 4 dS m⁻¹ to the experimental soil, which was a loam with a pH (0,01 m Calcium-chloride) of 6.8 and a very low salt content (ECe of 0.3 dS m⁻¹).

The Ethiopian varieties Mexican 142, ANO 1063, Ayenew and CAL 27 showed the highest salt tolerance, leading to 106.1, 98.6, 90.8 and 82.0 % yield of biomass (dry matter of roots and shoots) at an ECe of 4 dS m⁻¹, respectively, compared to no salt application. For Mexican 142, we observed an excluder mechanism for sodium and chloride, which means a protection of plant tissue by salt exclusion, while ANO 1063 seems to be more an includer variety, taking up the sodium, which can be used as osmotical adjustment in order to overcome the water stress, which is due to salt injury. The varieties Awash 1, Gofta, Almut, G 9872, Maxi and Red Woleita were not as tolerant as the previous ones, their biomass was reduced to a dry matter yield of 78.3, 74.8, 73.2, 71.8, 67.1 and 65.6 %, respectively, if grown on a soil with an ECe of 4 dS m⁻¹, compared to the no salt control (=100 %). The varieties Negra, Roba 1, Vollenda and G 3339 were the most sensitive ones, leading to a root and shoot dry matter yield of only 62.5, 61.6, 51.9 and 45.4 %, respectively, compared to no salt application.

It could be seen, that, in spite of the observed varietal differences, nearly all *P. vulgaris* varieties tested had a threshold of less than 4 dS m⁻¹ and were very salt sensitive.

Keywords: Ethiopia, *Phaseolus vulgaris*, salt tolerance

The Potential of Cash Crop Halophytes to Maintain Yields and Reclaim Saline Soils in Arid Areas

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About 7 % of the world's total land area is affected by salt, as is a similar percentage of its arable land. When soils in arid regions of the world are irrigated, solutes from the irrigation water can eventually reach levels that have an adverse affect on plant growth. There are often not sufficient reservoirs of freshwater available and most of the agronomically used irrigation systems are leading to a permanent increase in the soil-salinity and step by step to growth conditions unacceptable for most of the conventional glycophytic crops. Although careful water management practices can avoid, or even reclaim damaged land, the sustainable use of halophytic crop varieties that can maintain yields in saline soils or allow the more effective use of poor quality irrigation water will have an increasing role in agricultural land use in near future. A screening procedure is a practical first step on the selection of economically and ecologically important crop halophytes. This quick check system bases on the four major constraints for plant growth on saline substrates: water deficit, restriction in the uptake of CO₂, ion toxicity and nutrient imbalance. It comprises the study of the individual physiological and anatomical adaptations to counter the dual hazards of water deficit and ion toxicity.

Informations about the essential eco-physiological needs of several salt and drought resistant crops (such as *Beta vulgaris* and *Chenopodium quinoa*) and halophytes (such as *Atriplex nummularia* and *Spartina townsendii*) will be presented. Their characteristic combination of mechanisms against salt or drought injury will be discussed.

Keywords: *Atriplex*, *Beta vulgaris*, cash crop halophyte, *Chenopodium quinoa*, drought, NaCl tolerance, quick check system, *Spartina*

Survival of *Atriplex leuoclada* Bioss at Saline Habitats

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Sustainability of intensive irrigated agriculture in Egypt has become a critical issue, as the land and water resources are limited on one hand and population is increasing rapidly on the other hand. The sustainable use of halophytic plants is a promising approach to valorise strongly salinised zones unsuitable for conventional agriculture and mediocre waters. There are already many halophytic species used for economic interests (e.g. fodder, human food) or ecological reasons (soil desalinisation, dune fixation, CO₂-sequestration). However, the wide span of halophyte utilisation is not yet explored to a small degree.

A precondition for a sustainable utilisation of suitable halophytes such as *Atriplex* ssp. is a precise knowledge about the various mechanisms (physiological mechanisms and morphological structures) countering the dual hazard of water deficit and ion toxicity. Chenopodiaceae was studied in a quick check system (QCS, up to 150 % seawater salinity).

NaCl induced growth stimulation of *Atriplex leuoclada* which was optimal at moderate salinities (125 — 250 mM) NaCl. *Atriplex* was able to survive NaCl salinity up to more than 100 % seawater salinity.

NaCl salinity generally induced a decrease of CO₂ assimilation but a growth stimulation and also an increase of the water content up to 50 % sws. NaCl salinity induced a significant accumulation of Na especially in the adult leaves and a decrease in the content of essential nutrients such as K, Ca and Mg in all plant parts. Accumulation of inorganic ions seems to be involved in the osmotic adjustment. The surplus of NaCl was excreted via salt hairs.

An increase of the total soluble protein was observed with increasing salinity. Further investigations are necessary especially at the molecular level in order to understand the influence of NaCl on the protein composition.

Our results indicate that *A. leuoclada* can be grown productively at moderate salinity.

Keywords: *Atriplex*, cash crop halophyte, gas exchange, growth, NaCl salinity, sustainable use, water relations

Ecophysiological Responses of *Chenopodium quinoa* to NaCl Salinity

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Quinoa (*Chenopodium quinoa* WILLD), which is also called ‘mother grain’, is an important food crop in the Andes of South America and has been cultivated there for over 5000 years.

Its seeds have an exceptionally well balanced amino acid profile and they are high in vitamins and minerals. Even the NASA considered it as a potential crop for their Controlled Ecological Life Support System and the demand, especially in the United States of America is rising.

Quinoa shows resistance to adverse abiotic factors like drought and cold. However there is still not much known about its ability to cope with saline soils although the family Chenopodiaceae contains several halophytic species like *Atriplex nummularia* or *Chenopodium maritimum*.

The aim of the present study was to investigate the adjustment of this plant during the increment of the soil salinity. Plants were grown in a quick check system and final NaCl concentrations were 100 mM NaCl (0,6 %) and 300 mM NaCl (1,8 %).

Growth, water relations, CO₂/H₂O gas-exchange, ion- and protein composition were measured to study the major constraints of NaCl salinity.

100 mM NaCl lead to a transient increase of the growth. The growth reduction at higher salinities depended much on the period of time over which the plants have grown under these conditions. The data are consistent with the concept of two - phase growth response to salinity. In the first phase CO₂/H₂O gas-exchange decreased due to water stress or osmotic phase.

In the second phase at high salinity, salt was accumulated in transpiring leaves for osmotic adjustment (includer mechanism). Simultaneously the CO₂-concentrations in the intercellulars decreased and high light intensities lead to oxidative stress. This was shown by the rising concentration of detoxifying enzymes in the high salinity treatment.

As a consequence of our study we recommend to extend the use of *C. quinoa* to deserted and saline regions (semi-arid), where the water quality (medium salinity) and availability hinder the growth of other conventional crops.

Keywords: *Chenopodium quinoa*, drought, NaCl, osmotic adjustment, oxidative stress, proteomics, salinity, two-phase growth response

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Moisture Stress Risk Management to Cope with Food Insecurity in Ethiopia

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The risk farmers' face due to the variability in the quantity and distribution of rainfall in agriculture is paramount in the drought prone areas of Ethiopia. However, it is not known how farmers perceive and manage the risk due to this variability. Therefore, this research aimed at analysing farmers' strategies to cope with the production risks due to the unreliable rainfall in Kalu district of South Welo zone in North Eastern Ethiopia. For methodological reasons livestock enterprises were not considered.

The area was stratified into less (LMS) and highly (HMS) moisture stress. Data on states of moisture availability and the associated subjective probabilities of farmers, crop yield, resource use, and prices of products were collected. The quantitative data were analysed using stochastic dominance (SD) and parametric linear programming (PLP) models.

Farmers' moisture risk coping strategies are mainly explained by the allocation of farm land among the different crops produced. In the LMS of Kalu, farmers increase land allocated to tef, chickpea, lentil, field pea, and emmer wheat when they expect moisture stress, while farmers in HMS increase land for tef, chickpea, maize, and haricot bean instead of sorghum.

The results of the SD analysis for LMS identified faba bean, field pea, and sorghum; where as tef, sorghum and chickpea were identified as dominant for the HMS with first or second degree stochastic dominance criteria. The mean-variance risk efficiency analysis with PLP for LMS included wheat as a substitute of faba bean to reduce the variability of expected gross margin as wheat has low variability and covaries inversely with sorghum, lentil, chickpea, emmer wheat, maize, and faba bean. For HMS areas, the model introduced haricot bean and maize to reduce the variability in expected gross margin in the risk neutral plan dominated by tef.

The results justify farmers' moisture stress risk coping strategies. And yet, consideration of the model results would improve the efficient mix of crops to cope with moisture stress risk even better. A higher emphasis on land allocation to pulses and cereals achieving attractive market prices is, therefore, recommended to improve the returns of the farming community.

Keywords: Moisture stress, parametric linear programming, stochastic dominance criteria

Drought Performance in Millet (*Panicum miliaceum*) and Grain Sorghum (*Sorghum bicolor* L. Moench)

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Grain Sorghum (*Sorghum bicolor* L. Moench) and Millet (*Panicum miliaceum*) serve as one of the most important staple cereals in drought-affected areas of our globe, where annual rainfall is at its minimum. Their ability to grow and generate substantial yields under water limiting conditions has been attributed to their drought avoiding and tolerating characteristics.

Three genotypes representing three different maturity groups of each crop were cultivated in sand/nutrient media in a glasshouse. Control plants were maintained at field capacity (soil water potential; SWP at -60 to -80 hP). Stress was imposed at 50 % blooming by withholding water supply from an automatic irrigation system until SWP reached -200 hPa and was maintained for ten consecutive days. This was followed by re-irrigation to field capacity until harvest.

The objectives of this experiment were: (1) To determine if there is any differences in the physiological and morphological response of both crops to water stress; (2) To verify any differences between three maturity groups of each crop in response to water stress; (3) To evaluate the effect of water stress on water use efficiency by looking at Evapo-Transpiration Efficiency (ETE) and harvest indices; And (4) To assess the impact of water stress on yield and its relationship to the “Stay Green” character (if any) in both crop types.

Generally, water stress had a negative effect on the photosynthetic process of both crops. However, this was stronger in grain sorghum than in millet, with the late maturity genotypes of both crops been mostly affected. Also, the yields of sorghum were more drastically reduced by water stress than their millet counterparts. This was also the case for the above ground biomass and tiller production. The harvest indices of millet were relatively stable though not optimal as compared to their sorghum counterparts. The water use efficiency of the various millet maturity groups was significantly higher than their sorghum counterparts both under controlled and water stress conditions.

These results can be used to facilitate crop selection for farmers or breeders in drought affected areas relative to their cultivation or breeding programs respectively.

Keywords: Drought performance, gas exchange, grain sorghum, millet, water use efficiency

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Physiological and Morphological Responses of Four Centrosema Species to Preconditioning Periods of Soil Water Deficits: An Ongoing Research in Venezuela

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A critical environmental constraint in seasonal savannah ecosystems is the lack of available soil water during the dry period. This is usually accompanied by high temperatures, which induce a high evaporative demand. Identification of plant traits promoting survival and long term persistence under drought are necessary for any intended use of legume species to improve forage resources in these areas.

The genus *Centrosema* comprises 34 species which are native to the American tropics and subtropics. Some of these species show a combination of escape, avoidance and tolerance strategies that allow for better performance under soil drought. Though a positive correlation exists between the degree of osmotic and stomatal adjustment and drought tolerance, an inverse correlation has also been reported. Within *Centrosema*, it is more likely that a wider interspecific variation exists in the degree of control of stomatal closure and other traits such as: reduced leaf area, deep rooting and accumulation of osmosolutes, which contribute to reductions in water loss and prolonged plant growth.

It is well known that the response to water deficits will depend on the duration and intensity of soil drought. Likewise, many plants can withstand more intensive water deficits when subjected to a conditioning or hardening period in comparison to well-watered plants, due to the capacity to express all the inherent mechanisms available for survival under drought.

Consequently, a glasshouse experiment has been set up to study the morphological and physiological responses of four *Centrosema* species (*C. rotundifolium* CIAT 5721, *C. molle* CIAT 15160, *C. macrocarpum* CIAT 5713 and *C. brasilianum*) to water stress after a conditioning period. This acclimation phase consists in subjecting 50 days old plants to three soil water holding capacities: 100, 67 and 33 % of field capacity, for a period of about 20 days. Subsequently, plants are re-watered for 3–5 days before being exposed to a continuous soil drying in comparison to well-watered controls. Water relations, photosynthesis, soil water use, plant yield and biomass allocation will be measured during the drying phase. Results are expected to identify distinct mechanisms responsible for observed differences in growth and survival under field conditions.

Keywords: Acclimation, biomass production and allocation, centrosema, photosynthesis, soil drought, water relations, water use

Prediction of Soybean Seed Viability and Quality in Relation to Seed Moisture Content and Storage Temperature

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The objective of prediction of soybean seed viability and quality in relation to seed moisture content and storage temperature is to evaluate the viability and quality changes at various conditions and establishing equations for predicting seed quality in relation to seed moisture content and storage temperatures. The experimental design was arranged in Factorial Completely Randomised Design and the multiple regression analysis were used to create predicting equations. Soybean seeds of the cultivar Chiangmai 60 with four initial seed moisture contents of 6, 8, 10 and 12 % and five storage temperatures of 15, 20, 25, 30°C and room temperature were used to store seed for 120 days and the assessment were done every 2 weeks. Standard germination test, vigour test by accelerated aging technique, vigour test by tetrazolium technique, electrical conductivity test, seedling growth rate, fungi infection, protein, lipid and carbohydrate were investigated. The result showed that at the beginning of seed storage the seed qualities were still high and decreased when the period of storage increased in all conditions except percentage of the fungi infect, protein, lipid and carbohydrate contents, did not show any significant difference. The prediction of equations was represented: viability and quality were dependent variable (Y) and initial seed moisture content (X_1) storage temperature (X_2) and period of storage (X_3). The best equation for standard germination is:

$$Y = 79.695 + 1.546 (X_1) + 0.660 (X_2) + 0.674 (X_3) - 0.069 (X_1X_2) - 0.116 (X_1X_3) - 0.035 (X_2X_3) - 0.018 (X_3)^2 \quad (R^2 = 0.9340).$$

Keywords: Prediction, quality, seed moisture content, soybean seed, storage temperature, viability

Breaking Dormancy and Optimum Storage Temperature of Golden Shower (*Cassia fistula*) Seeds

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Golden flower, the ornamental shrub is recognised as the symbol of Thai national tree since 2004. Propagation is practised by seeding and transplanting. Dormant seeds are commonly found due to hard seed and low germination rate. Optimised germination requirements are not recorded. This experiment is separated into two parts: dormancy breaking methods and optimum storage temperature investigation. Newly harvested golden shower seeds with 10 % moisture content were brought to Chiang Mai University Seed Testing Laboratory. Three methods of dormancy breaking were trailed: pierce at the part of cotyledon, acid scarification by using H₂SO₄ conc. for 5, 10, 15 and 20 minutes, and hot water treatment by soaking in 50, 55, 70 and 90°C for 30 minutes. Standard germination test after treatment are recorded. In the second experiment: three storage temperatures; 15, 28 and 37°C were used. Seeds were kept in storage with 60 % relative humidity for 12 weeks. Seed quality was assessed every 3 weeks, which were standard germination test, seed viability by tetrazolium test and seed vigour by accelerated aging technique. The result from the first experiment showed that acid scarification treatment for 15-20 minutes was the best method for breaking their dormant period which resulted in an increased germination rate up to 81%. However in the second experiment it was found that the seed viability, the germination percentage and the seed vigour stored in 28°C showed significantly better results than in the two other storage environments. It can be concluded that acid scarification is optimised in breaking golden shower seed dormancy, and that 28°C storage is suitable for 12 weeks storage period.

Keywords: Breaking dormancy, golden shower (*Cassia fistula*), storage temperature

Leaf Senescence-Inducible Expression of Isopentenyl Transferase in Cassava Rendering it Resistant to Drought Stress

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It is well-known that cassava (*Manihot esculenta* CRANTZ) could stand prolonged abiotic stress and survives by shedding its leaves. Cytokinins exhibit antisenesescence and drought resistance properties. Expression of the isopentenyl transferase (*ipt*) gene, which encodes a key enzyme for cytokinin biosynthesis, from *Agrobacterium tumefaciens* under control of the senescence-induced SAG12 promoter from *Arabidopsis* should lead to delayed cassava leaf senescence via an autoregulatory senescence inhibition system. We have transformed cassava plants with the *ipt* gene under control of the SAG12 promoter. The insertion of the SAG12-*ipt* cassette has been confirmed in seven cassava plant lines by Polymerase Chain Reaction (PCR) and Southern analyses. Five out of them could be detected low expressions of *ipt* in mature leaves by RT-PCR analysis. After dark-induced senescence treatment of mature leaves from both in vitro and greenhouse-grown plants, significant stay-greenness and repressed chlorophyll degradation were observed in the transgenic lines 529–28 and 529–48 compared to wild-type. The lines also displayed resistant to leaf senescence after drought treatment. Only 10 % leaves of 529–28 become senescent in comparison with 50 % of wild-type and 20 % of line 529–48 from 3 month old plants. The expression of *ipt* was increased in the old leaves of drought-treated 529–28 lines. During the development of transgenic plants, the decrease in chlorophyll, total protein, and Rubisco content in mature leaves was repressed. Interestingly, the transgenic plants also showed an early storage root bulking in comparison with wild-type plants. Evaluation of the yield of leaves and storage roots as well as drought resistance level will be field-trialed at CIAT, Colombia.

Keywords: Cassava, drought resistance, leaf retention, senescence-induced IPT expression

Phyllochron of Lowland Rice Does Not Depend on Temperature Alone

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Developing cropping calendars to accommodate newly introduced crops requires flexibility in planting dates of the members of the existing crop rotation. In the midhills of Nepal, changing planting dates exposes the crop to new thermal environments changing both the overall duration and the speed of crop establishment. Crop establishment depends on the speed of leaf appearance and the longevity of individual leaves, which have been shown to be temperature depending. At eight planting dates staggered at 15 day intervals six lowland rice genotypes were planted in a rice garden in Lumle, Nepal. The appearance and development of successive leaves was observed up to leaf number 12. Germination was linearly and phyllochron was quadratically correlated with the phyllochrons' mean air temperature. Genotypes differed in their optimum temperature for leaf appearance. However, with each succeeding leaf appearance the influence of temperature on the phyllochron was less pronounced and ceased entirely after the appearance of leaf number five. For later leaves and particularly at later planting dates leaf appearance rate decreased independently of temperature and leaf development rate slowed down. With limited resources plants need to balance sinks against sources. The development stage of a leaf was expressed as a normalised senescence level or source-status. These were added-up for all existing leaves on the main tiller. The resulting figure was used as an overall senescence indicator for the tiller. Independent of planting date leaves were initiated at a genotypic level of tiller senescence after leaf number eight. The higher the level, the slower was the leaf turnover in the canopy. For early planting dates genotypes having a low optimum temperature for leaf appearance need to be selected, whereas for later planting dates where early leaf development is fast due to higher temperature, leaf longevity becomes an important factor for a sustainable source for grain filling.

Keywords: Cropping calendars, leaf appearance, phenology, phyllochron, planting date, plastochron, rice

A Low Cost Miniature Method to Determine Iron Content in Samples Suitable for Small Research Laboratories

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The determination of iron contents in plant or soil samples is relatively laborious and involves expensive equipment such as a high-pressure acid digestion system and an atomic absorption spectroscope. The method requires relatively large amounts of sample material and due to the costs involved only a limited number of samples can be analysed per day. Therefore, this method is in many cases unsuited for laboratories of small research or field stations. In order to reduce sample size required as well as costs and equipment requirements we developed an analytical method that uses micro titer plates and a plate reader. As test materials rice tissue samples were used from an experiment on genotypic tolerance to iron toxicity. Individual samples size was between 0.03 and 0.15 g. Samples were finely ground using a self made ball mill with achate balls to avoid iron contamination at milling. Samples were extracted by heating to 120 °C in a pressure cooker, filtered and pipetted onto a micro titer plate. Sodium dithionite was added to reduce all iron present to FeII, and the wells were filled up with 2,2 Dipyridil, which forms a stable red complex with FeII. Micro titer plates were read in a plate reader at 490 nm. The accuracy of the method was tested by comparing the results with data obtained by the original standard method from the same sample. The method will be tested for soil extracts in the near future. The new provides a way to determine the iron content of plant tissue samples on the basis of small sample sizes for less then a tenth of the costs of the original standard method. Implications of the new method for the use in small low budget laboratories will be discussed.

Keywords: Iron complex, iron determination, mikro titer plates, miniature analytics, photometry, rice

Assessment of Flower and Fruit Formation in *Solanum gilo* and *Solanum macrocarpon*

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Two field trials were carried out to assess the flower and fruit formation in *Solanum macrocarpon* and *Solanum gilo* at Ibadan Nigeria.

In the first trial, seedlings of the two species were raised in the nursery and transplanted at plant spacing of 100 cm by 15 cm on a sandy loam soil, while in the second trial only *S. gilo* was planted with different levels of NPK fertiliser (0, 125, 175 and 175 kg NPK/ha split applied twice). Experimental design was randomised complete block with three replications.

In the first trial, the mean total number of flowers produced per plant was 37.4, of this number 19.4 (52 %) was formed from terminal inflorescences of the primary branches while 18.0 (48 %) were from the lateral branches.

The proportion of flower that developed to mature fruit was 22 % representing 10.4 % and 11.8 % from the primary and lateral branches respectively. A total of 82.9 flowers per plant opened in *S. gilo*, of this 26.3 (31.7 %) from the primary, 47.3 (57 %) from lateral and 9.3 (11.2 %) on the axillary. The total numbers of flower aborted in *S. macrocarpon* and *S. gilo* were 77.8 % and 89.3 % respectively.

In the second trial, the number of flowers opened per plant ranged between 31 and 71 and the highest were from plant treated with single application of 175 kg NPK/ha although there were no significant differences by splitting the same amount, followed by 125 kg NPK/ha and the control gave the least. The rate of flower abscission was generally high with about 66 % of the opened flowers aborted.

Fertiliser application generally enhanced yield, plants without fertiliser produced fruits which were smaller and fewer in numbers, fertiliser reduces flower abscission, however, it did not stabilise fruit yield sufficiently in that more of the opened flowers aborted with only a few forming matured fruit. Therefore factors other than nutrients might have been responsible for this.

Keywords: Abscission, flower, formation, *Solanum gilo*, *Solanum macrocarpon*

Root Associated Bacteria Suppress Symptoms of Iron Toxicity in Lowland Rice

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The beneficial effects of root-associated bacteria in biologically controlling soilborne pathogens have been well established. Conversely, little is known about how these beneficial microorganisms affect responses of plants to abiotic stresses. An investigation was thus undertaken to evaluate whether root-associated bacteria endemic to rice could be used to mitigate the effects of iron toxicity symptoms in lowland rice. To date no bacteria strain is known to positively affect plant responses to iron toxicity. We isolated several strains of *Bacillus* from surface sterilized seeds of lowland rice and maintained them at -18 °C. In a hydroponic system, four of those, *B. megaterium*, *B. pumilus*, and two isolates of *Bacillus* not yet identified to species level, were used to inoculate root systems of 3-week-old seedlings of six rice varieties differing in iron toxicity tolerance. Seven days after inoculation the rice seedlings were subjected to two concentrations of FeII (0 and 1000ppm). Five days after the onset of the treatments the rice varieties were visually assessed for toxicity symptoms and compared with two controls that were not inoculated with any bacteria. Typical symptoms of iron toxicity were brown spots on the leaves and the brown-orange colouring of the leaves known as broncing. Under non-toxic conditions, inoculates generally promoted growth and in one case (*B. megaterium*) promoted internodal elongation as compared to non-inoculated controls. Three of the inoculates significantly reduced symptoms of iron toxicity in all tested varieties, whereas one (*Bacillus* sp.) significantly aggravated the symptoms. Analyses of iron uptake and distribution for the six rice varieties (on-going) will elucidate the underlying mechanisms of bacterial effects on iron toxicity tolerance in rice. Possibilities for practical applications will be discussed.

Keywords: *Bacillus* sp., hydroponics, iron toxicity, rice, root-associated micro-organisms

Influence of the N-Fertilisation on the Drought Tolerance of *Chenopodium quinoa* Willd.

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Chenopodium quinoa is an old crop from the Inca civilisation. Its seeds have a huge nutritional value and have the potential to become a “supergrain”. Due to the low nutrient requirements of quinoa, it is able to grow to higher altitudes, in scanty and stony habitats.

One aim of this study was to understand how it can manage to develop at nitrogen-poor soils. Nitrogen, one of the most important nutrients, presents limited availability, especially in arid and semi-arid regions of many parts of the world, where water and nutrient supply will be in future (or are already) the major growth limiting constraints. There is an essential need to find new crops that are able to sustain periods of low precipitation in oligotrophic soils.

Quinoa is known to be drought tolerant. We studied adaptative strategies to a combined deficiency of water and nitrogen to determine its potential to grow under these conditions. Plants were grown at three nitrogen levels (1, 6 and 26 mM). After two weeks the cultures were split into these treatments, control and drought. Drought stress was applied by decreasing constant (highly controlled) and slowly the content of soil water (from 25 % to 5 %).

The nitrogen supply correlates as expected with the biomass production. Additionally, morphological and osmotic changes were related to a decreasing soil water potential. However, water use efficiency and net photosynthesis were at the same time affected by drought stress, especially in plants with bigger leaf surfaces and growth rates (high-N-treatments). Stomatal resistance increased generally at all drought conditions.

It has been shown that the “Corn of the Andes” is highly drought tolerant even with low nitrogen situations. It is most suitable to grow in extreme environments, such as deserts and mountainous regions. Unfortunately, the potential of this useful alternative crop is by far not exploited.

Keywords: Crop, drought, fertiliser, nitrogen, quinoa, water stress

Transpiration and Assimilation and their Relationships to other Morphophysiological Characteristics in Cowpeas under Water Deficit Stress

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This study on cowpea (*Vigna unguiculata* (L.) Walpers) was carried out from October 2003 to March 2004. The aim was to determine the effect of water deficit stress, just before flowering, on transpiration and assimilation rates and their relationship to each other and to other characteristics particularly water-use efficiency (WUE), leaf area (LA) and specific leaf area (SLA).

Six cowpea genotypes from Zimbabwe, Nigeria, India, Kenya and USA were subjected to drought stress or well-watered throughout. Drought stress was induced 43 days after sowing (DAS) for 21 days. A gradual dry-down of the substrate (sand) took place until the soil water potential was $-350\text{ hPa} \pm 50$. Up to 64 DAS (14 days) the soil water potential was maintained at this level. From 65 DAS all plants were well-watered (soil water potential $-60\text{ hPa} \pm 20$). Four plants per genotype and water treatment were harvested at day 42 and 64. Two days before harvest transpiration and assimilation were measured and leaf area determined.

42 DAS (before water deficit stress) UCR 328 had the highest transpiration rate, which differed significantly from that of UCR 1340. There were no significant differences between all the other genotypes ($p < 0,05$). UCR 386 had the highest assimilation rate. This genotype showed a significant difference to UCR 1340, which had the lowest assimilation rate. 64 DAS (at the end of water deficit stress) UCR 328 had the highest assimilation rate for the well-watered treatment, UCR 386 had the lowest. For the well-watered treatment transpiration and assimilation rate showed a weak correlation to WUE but a strong one to each other (0,935; $p < 0,01$) 64 DAS. In the drought treatment transpiration and assimilation rate showed a strong linear correlation to each other, to WUE and to stomatal conductance.

More studies are going to be carried out to determine and verify these and other relationships in cowpea under drought stress in the greenhouse.

Keywords: Assimilation, cowpea, transpiration, water deficit stress, water-use efficiency

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Physiological Adaptations in Response to Drought Stress in Four Wild Populations of *Coffea arabica*

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The ecophysiological basis of drought tolerance was examined in four wild populations of *Coffea arabica* from an ecocline in Southern Ethiopia, which runs from the drier Bale Mountains with an annual precipitation of 790 mm to the wetter area in the Southwest with 2200 mm per yr. It was hypothesised that this gradient in water availability would promote regional differentiation in ecophysiological traits that allow the identification of drought tolerant coffee populations.

In order to eliminate possible confounding effects, seedling from the four provenances of wild coffee were used for an ex-situ experiment under controlled environmental conditions. A completely randomised split-split plot design was established, based on the 12 subpopulations within the 4 main populations. Two irrigation levels as well as two light regimes were imposed over a 16-days period. Throughout the experiment seedling survival and physiology were monitored every four days by measuring leaf water potential, diurnal gas exchange as well as leaf carbon isotope discrimination on randomly selected individuals.

The selected coffee populations, occupying a broad range of stands with different habitat conditions, show considerable variability in their physiological behaviour. At the end of a 16 days treatment, predawn water potential of the plants in the well watered plot remained above -3,0 bar whereas the values of the stressed plot declined to -36,2 bar. Particularly plants from Berhane-Kontir allowed leaf water potential to be maintained for a longer period of time and delayed the appearance of stress symptoms in comparison with the other populations. These results suggest that this provenance is relatively tolerant of desiccation compared to the coffee populations from the other habitats. This may give this population a competitive advantage during drought events.

Keywords: *Coffea arabica*, drought response, ecophysiology, environmental heterogeneity

Plants and Biotic Stresses

- ROLF T. FOLKERTSMA, BETTINA I.G. HAUSSMANN, HEIKO K. PARZIES, VOLKER HOFFMANN, H. H. GEIGER:
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Arresting the Scourge of *Striga* on Sorghum in Africa by Combining the Strengths of Marker-Assisted Backcrossing and Farmer-Participatory Selection

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Sorghum is the staple food for millions of people in sub-Saharan Africa. The parasitic weed *Striga hermonthica* is a major constraint to sorghum production in this region with yield losses due to *Striga* reported up to 100%. *Striga*-resistant sorghums would be an important component of integrated *Striga* control if resistance was available in locally adapted farmer-participatory selected varieties. The application of marker-assisted selection in *Striga* resistance breeding will greatly accelerate progress since field screening is difficult, complex, and often unreliable; *Striga* seed is quarantined thus confining tests to areas where *Striga* is endemic; and because some *Striga* resistance genes are recessive, increasing the time required for conventional backcrossing. QTL mapping for resistance of sorghum to *S. hermonthica* was performed using a population of F3:5 lines developed from the cross N13 × E36-1, where the resistant sorghum line N13 is characterised by “mechanical” resistance (Hausmann et al., 2004). Composite interval mapping detected five QTL common across 5 environments over two years of *Striga* resistance evaluation, with the resistance alleles deriving from N13. Since their effects were validated across environments, years and independent genotype samples, these robust QTL are excellent candidates for marker-assisted selection. In a three year project, launched in April 2004, *Striga* resistance of farmer-preferred sorghum varieties in Eritrea, Kenya, Mali and Sudan will be enhanced through a combination of marker-assisted backcrossing and farmer-participatory selection. The impact of gene flow on the stability of the achieved *Striga* resistance will be investigated in a complementary study. Simultaneously, a socio-economic study of the sorghum seed supply systems in these countries will be undertaken to guide the design of effective seed interventions by partner institutions so that improved materials efficiently reach farmers. Linkage with technology exchange will boost promotion of the improved varieties as component of integrated *Striga* control.

Keywords: Farmer-participatory selection, Marker-assisted backcrossing, QTL, *Sorghum bicolor*, *Striga*

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International Scientific Cooperation as Base for Preventive Consumer Protection: Implementation of Biological Plant Protection Factors in Chinese Greenhouse Vegetable Production

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Initiated by the German Ministry of Consumer Protection, Food and Agriculture and the Chinese Ministry of Agriculture, a cooperation between partners of the Chinese Agricultural University, Beijing, Xinjiang Academy of Agricultural Sciences, Urumqi, and Chinese Academy of Sciences with the Federal Biological Research Centre for Agriculture and Forestry (BBA) a) introduces the new mycorrhizal technology for an integrated plant protection strategy to Chinese horticulture, b) expands the basic knowledge of Chinese scientists about the population dynamics of pests and pathogens on vegetables under greenhouse conditions, c) promotes the development of new soil improvers/biofertiliser products in China, and d) demonstrates sustainable, consumer oriented methods for horticulture to Chinese students, scientific professors and supervisors of plant producers. Therefore, future developments of Chinese plant protection strategies will have the chance to be designed more adapted to compliance criteria of farm assurance systems as important catalogues of food quality control criteria. Furthermore, the cooperation of BBA with Chinese partners increases the expertise of German scientists on the field of use of biological plant protection factors under biotic stresses in greenhouses and enhances specific knowledge about Chinese horticultural and agricultural plant production systems.

Since 2002, in demonstration projects under practical conditions the following steps have already been realised: a) The mycorrhizal technology at the XAAS (Urumqi) was established, b) biological control of biotic stressors (nematodes and fungal pathogens, insects etc.) on tomato, bell pepper and cucumber by beneficials and mycorrhizal fungi under greenhouse conditions is recently carried out, c) eco-physiological studies on mycorrhizal functioning under greenhouse conditions (influence of light, nutrition, population biological means etc) have started demonstrating the strong interest of all partners in the consumer oriented research.

Keywords: Biological plant protection, China, greenhouse, horticulture, mycorrhiza, vegetable

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Opportunities for Nematode Biocontrol in Lowland Rainfed Rice Using Bacterial Endophytes

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Meloidogyne graminicola is an important pest in several rice producing areas of South and Southeast Asia, particularly in lowland rainfed rice production systems where early season soil flooding is intermittent or absent. Cultural practices associated with lowland rainfed rice — seedling establishment in nursery beds, cut-root transplantation, and post-transplant soil flooding — present interesting opportunities for biologically controlling this and other plant-parasitic nematodes. A research project was recently initiated at the Institute for Plant Protection, University of Bonn to investigate bacterial endophytes of rice for biological control of *M. graminicola* and *Hirschmanniella oryzae*, with a focus on utilising bacterial endophytes to protect the rice seedling root system during critical early season growth. In *in vivo* screening tests, *Bacillus megaterium* was found to have high activity against *M. graminicola*. Rice seedling inoculation with this bacteria significantly reduced nematode galling severity and J2 penetration compared with non-inoculated controls. Additionally, *in-vitro* tests using cultural filtrates of *B. megaterium* significantly delayed nematode egg hatch and reduced J2 mobility. The goals of the project are to isolate and screen bacterial endophytes from upland and lowland rice producing zones for their antagonistic potential and to develop effective and low-cost means for delivering the endophyte to the seed at nursery establishment and to the seedling at transplanting. This paper will discuss concepts of endophytic biocontrol of nematodes, methods for introducing endophytes in rice roots, and modes of action through which *B. megaterium* impacts *M. graminicola* activity, and strategies for combining biocontrol with floodwater management to control nematode damage in rice.

Keywords: Bacterial endophyte, biological control, rice, root-knot nematode

Plant Pathogenic Rust Fungi from Tropical and Subtropical Regions: A Monograph of the Genus *Hemileia* (Uredinales)

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With about 7000 species, rust fungi are the biggest group of obligate plant parasites. They are worldwide distributed and have an enormous economical significance. Nevertheless, rusts from tropical regions are still insufficiently studied and summarising works, e.g. floras and monographs are widely lacking. The aim of the present work was to prepare a monograph of the genus *Hemileia* and to contribute thereby to the knowledge about tropical rust fungi. The type species of *Hemileia*, *H. vastatrix*, parasitises on coffee and represents one of the economically most important pathogens within the coffee growing regions. The morphology and the parasitism of the species have therefore been examined by numerous mycologists and phytopathologists. Much less information exists, however, about the other representatives of *Hemileia*. Forty-two species are so far known, occurring mainly on members of the Rubiaceae and Apocynaceae within the tropical to subtropical regions of Africa and Asia. Seventeen of them are based on the uredinial stage only, twenty-five are also known as the teleomorph. Aecia or spermogonia belonging to *Hemileia* have not been found so far and the life cycle is still incompletely known. All species, as far as available as herbarium specimen, were observed by means of light- and electron microscopical methods. The present monograph contains information about the history and taxonomy of the genus, as well as detailed descriptions and illustrations of all *Hemileia* species. Doubtful, unclear and excluded species were also listed and discussed. A list of host genera and species, together with keys to the *Hemileia* species occurring on them, is also provided as a tool for determination.

Keywords: Determination, *Hemileia*, monograph, rust fungi, Uredinales

Planting Date as a Potential Parameter for Sustainable Cotton Production in Myanmar

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Cotton is of outstanding importance in Myanmar, being used for clothing, edible oil, and seed cake for fishery and dairy production. Moreover, cotton is an important cash crop for small farmers, and substantially contributes to export incomes of the nation. However, cotton production is made difficult due to several insect pests; yields are reduced by direct feeding damage and by quality reduction of fibres. Insecticide sprays are too expensive and applications difficult especially during periods of continuous light rainfalls, which are typical for cotton growing areas in Myanmar.

Most of the important pest species exhibit a strong seasonality in Myanmar. We hypothesised that planting dates adjusted to this seasonality will reduce the incidence of crop growth and peak densities of pests. A time window of reduced pest population densities would increase cotton yields in Mandalay Division, the main cotton growing area in Myanmar.

We tested this hypothesis by using the cultivar Lungyaw-3, widely used in Myanmar, adapted to the local conditions, and exhibiting at least partial resistance against some insect pests. We used a 3 times replicated field experiment using 3 planting dates (May, July, August), to record in weekly intervals pest and beneficial insects, weeds, and meteorological data. No pesticides were applied during the experiment.

The July planting date proved to be the best with regard to pest damage levels and yield. Although this planting date exhibited higher levels of insect densities, the cotton plants were able to compensate by producing new squares. The May planting date was the worst one; because of high temperatures and rain at harvest time, plants did not produce bolls and lint of high quality. When cotton was planted in August plant growth was enhanced, however, herbivore densities were high and plants did produce only small amounts of bolls. None of the planting dates resulted in significant differences in natural enemy densities.

Based on these preliminary data we recommend a planting date for cotton in Myanmar in July.

Keywords: Insect pests, sustainable cotton production, Myanmar

Investigations on *Citrus tristeza* Virus (CTV) and its Occurrence in *Citrus* Orchards in Arid and Semi Arid Zones of Sudan

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The *Citrus tristeza* closterovirus (CTV) is a filamentous plant virus and has a very narrow host range confined to species of Rutaceae in which it is limited to phloem-associated cells. CTV is a major pathogen of *Citrus* spp., often causes quick decline and death, or stem pitting and reduced vigour, longevity, and yields in susceptible varieties and hence considered as a serious threat to the *Citrus* industry worldwide. In Sudan all *Citrus* trees are grafted mainly on sour orange rootstock and this yields a CTV-susceptible combination with scions of sweet orange, mandarin, grapefruit and others. CTV is a serious problem because it is readily transmitted in infected budwood and is also spread by several species of aphids.

During the trials to detect CTV in the Sudan a survey was initiated in 2003 and 2004. Fresh leaf material was collected from CTV suspected trees in different areas of the Sudan accompanied by tissue printing on nitrocellulose membranes. CTV was detected successfully in thirteen printed samples originating mainly from orange trees but were collected from different orchards. In two cases also a mandarin and a lime tree respectively reacted positively in this serological assay. Starting from RNA, extracted from fresh leaves, in a nested RT-PCR approach from ten samples a specific PCR product was amplified, substantiating the presence of CTV in four trees (three orange, one lime tree), which were presumably tested positive by Tissue Print. Cloning and sequencing of 9 specific PCR products proved the presence of CTV in *Citrus* trees in Sudanese orchards. Nested PCR-products from 5 samples revealed identical sequences. The nested primers enclosed 78 bp sequence showed 99 % nucleotide identity to a CTV strain from California causing severe stem pitting symptoms (AF01623) whereas the other 4 samples are identical to the reference sequence (DSMZ PV-0332 from Israel) and showed 99 % identity with CTV strains T30 and T36 from Florida (AF260651 and U16304). The two different sequences obtained from Sudan revealed lower nucleotide identity about 97 %, indicating at least two different CTV-strains to be present in *Citrus* orchards in Sudan.

Keywords: *Citrus* virus detection, nested RT-PCR, Sequencing, Tissue printing

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Evaluation of Watermelon *Citrullus lanatus* Germplasm for Leafminer *Liriomyza* spp. Resistance

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Leafminer *Liriomyza* spp. are among the important insects infesting vegetables in Sudan. Two species of leafminer, *L. trifolii* Burges and *L. sativae* Blanchard, were reported in Sudan. The adult insects lay their eggs inside watermelon leaves where they hatching, and during the feeding process the larvae make mines inside the leaf tissues. The high number of mines leads to leaf drying. Sixty-eight local watermelon accessions, which include fifty-eight *Citrullus lanatus* accessions, seven *C. colocynthus* accessions and three *C. lanatus* var *colocynthoides* accessions in addition to three commercial cultivars, were subjected for evaluation in winter 1999. Moreover, seven selected accessions (5 *C. lanatus* & 2 *C. colocynthus*) from season 1998 and two commercial were also evaluated in winters 1999. The evaluation was repeated in winter 2000 using other eight accessions (3 *C. lanatus* & 5 *C. colocynthus*) in addition to two commercial cultivars. All accessions were evaluated depending on natural infestation under field conditions. The plants were evaluated during different growing stages. The parameters used to evaluate these accessions were mean of resistance and percentage of infestation. Mean of resistance were measured using a scale of 1–5 where 1 is resistant and 5 is highly infested. Percentages of infestation were scored by measuring the percentage of infested leaves from total counted leaves .

The evaluation of sixty-eight accessions revealed that *C. colocynthus* accessions were resistant (1.3–1.7), while *C. lanatus* and *C. lanatus* var *colocynthoides* accessions ranged between highly susceptible to moderately resistant (2.4–5.0). The evaluation of selected accessions for two seasons proved obviously that *C. colocynthus* accessions were significantly different from all other evaluated accessions and was accompanied also by low level of infestation.

Keywords: Leafminer, resistance, watermelon

Efficacy of *Beauveria* sp. in the Control of First Instar Larvae of the Andean Potato Weevil (*Premnotrypes suturicallus* KUSCHEL)

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The Andean potato weevil (*Premnotrypes suturicallus*) is a main insect pest for the potato production in the high Andes, causing 20–25 % yield loss through tuber damage. The objective of this research was to investigate the use of entomopathogenic fungi to control first instar larvae (L1) before they enter the tuber. In a first trial, potato tubers were placed into pots and covered with sterilized soil. In treatment 1 (T1), the larvae were inoculated with *Beauveria* sp.; in treatment 2 (T2) the soil was inoculated. Larvae were liberated on top of the soil. After 1 month, mortality in the control was 3 %, compared to 22 % in T1 and 12 % in T2. In a bioassay on potato tubers for alimentation the LC₅₀ assessed after 30 days as survival rate exceeded 1×10^8 conidia ml⁻¹. In another bioassay, without potato tubers, LC₅₀ was 5.3×10^5 conidia ml⁻¹ after 7 days. In order to understand the low mortality of larvae when feeding on tubers, the adherence of conidia to the insect cuticle was studied. L1 were inoculated with *Beauveria* sp. In treatment 1 (T3) larvae were placed on tubers, in treatment 2 (T4) larvae were kept in soil and in treatment 3 (T5) larvae were placed into empty eppendorf caps. After 24 h, larvae were washed with Tween 80 (0.1 %), the solution, applied on antibiotic agar and the number of colony forming units (cfu) assessed. The median values were 23.7, 2.3 and 626 cfu per larva for T3, T4 and T5 respectively. Both, SEM and fluorescent microscope studies revealed few or no conidia on the cuticle of larvae that were kept in soil or on tubers for 24 h, compared to a heavy load of conidia on the larvae in empty pots. These results indicate, that the first instar larvae can shed conidia from their cuticle and are therefore difficult to target with entomopathogenic fungi.

Keywords: Andean potato weevil, *Beauveria* sp., biological control, entomopathogenic fungi, potato pest, *Premnotrypes suturicallus*

Growth and Pathogenicity of Entomopathogenic Fungi *Metarhizium anisopliae* Against Termites

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Biological control with pathogenic fungi is a promising alternative to chemical control against the subterranean termite. Biological control with pathogenic fungi might provide long-lasting insect control without damage to the environment or non-target organisms. *Metarhizium anisopliae* is one of several natural agents for controlling a broad range of insects by direct penetration of the host cuticle. Using this fungus as the microbial insecticide is usually a part of insect pest management. Sporulation characteristics and virulence *M. anisopliae* were examined in relation to laboratory transmission in subterranean termite. Studies on physiology of *M. anisopliae* var. *anisopliae* and var. *majus* on 12 artificial media found that the medium which supported mycelium growth and sporulation was Sabouraud dextrose agar with yeast extract (SDAY). The optimum temperature was found between 25 °C–28 °C and fungi developed well in the pH range 6–8. The photoperiod for 24 hours per day produced green conidia more than other treatments. Two varieties of *M. anisopliae* were tested for their pathogenicity to workers of termites, *Coptotermes* sp. and *Microcerotermes* sp. Percent mortality of termites depend on concentration of conidia suspension, generation of fungi and variety of *M. anisopliae*. Termites apparently died after two days postinoculation and after seven days the white mycelia developed, the green conidia had appeared around the cadavers. The studies showed that both varieties of *M. anisopliae* could cause mycoses to the termites. However *M. anisopliae* var. *anisopliae* found more pathogenic virulence by producing epizootics higher than the *M. anisopliae* var. *majus*.

Keywords: Entomopathogenic fungus, *Metarhizium anisopliae*, termite

Effect of *Paecilomyces lilacinus* Strain 251 on the Survival and Virulence of the Entomopathogenic Nematodes *Steinernema feltiae*, *Heterorhabditis bacteriophora*, and *H. megidis*

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Modern agricultural practices often require the application of multiple types of control agents to reduce pest and disease damages. These methodologies must be compatible and integrated in overall production systems. In the present study, the compatibility of *Paecilomyces lilacinus* strain 251 with three entomopathogenic nematode species was investigated. *P. lilacinus* is a facultative egg pathogen of sedentary nematodes and commercially available in several countries for the control of a wide spectrum of plant parasitic nematodes. Entomopathogenic nematodes are important biocontrol agents against soil-inhabiting insect pests. The biocontrol efficacy of these entomopathogenic nematodes is due to obligate mutualism with insect-pathogenic bacteria that are carried within the nematodes' bodies. In a bio-assay the effect of the culture filtrate of *P. lilacinus* on the mobility of the entomopathogenic nematode (EPN) species *S. feltiae*, *H. bacteriophora* and *H. megidis* was investigated. Furthermore, the survival of these entomopathogenic species in soil treated with the fungus *P. lilacinus* was investigated after 1, 7 and 14 days. Additionally, the effect of the fungal biocontrol agent on the efficacy of the EPN tested against *Galleria mellonella* was determined using a sand column assay. It was demonstrated that there was no negative effect on the activity of the EPN tested after 24-hour exposure to the fungal culture filtrates. In addition, the survival and the virulence of the entomopathogenic species tested were not affected by the presence of *P. lilacinus*. In conclusion, the present study demonstrated that *P. lilacinus* strain 251 and the entomopathogenic nematodes tested are compatible elements of integrated pest management.

Keywords: Biological control, compatibility, entomopathogenic nematodes, *Paecilomyces lilacinus*

Importance and Strategies of Screening for Enhanced Biodegradation of Pesticides in Banana Plantations

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Worldwide control of banana nematodes, especially the burrowing nematode *Radopholus similis*, requires yearly and repeated nematicide applications. Non-fumigant versus fumigant nematicides are the most preferred for cost and environmental reasons. Enhanced biodegradation is the rapid microbial degradation of nematicides by a specialised fraction of the soil microflora that has evolved through pesticide selection to rapidly metabolise specific nematicides. It is the process by which microorganisms (bacteria, fungi or algae) convert materials into biomass, carbon dioxide and water. Enhanced biodegradation of fenamiphos, ebufos, terbufos, ethoprophos (organophosphates) and carbofuran (carbamate) have been observed in banana soils. If total nematodes per gram of soil are directly correlated with percentage of functional roots and with banana bunch weight and the crop does not respond to nematicide application then yield loss might be the consequence of enhanced biodegradation. When chemical control of nematodes is erratic after repeated applications, especially in this perennial cropping system, enhanced biodegradation needs to be studied as a possible cause. The development of efficient tests to detect enhanced biodegradation are needed in order to react to this situation and to recommend alternative control measures. Strategies like alternating between carbamates and organophosphates, to alternate every second treatment with a different nematicide and interrupting chemical application for 12 to 16 months have shown to reduce enhanced biodegradation. Biological control agents might be helpful in breaking the nematicide use cycle. In addition, biofumigation using cover crops and organic matter may induce shifts in microbial communities away from enhanced biodegradation. The results of field surveys on the occurrence of biodegradation as well as alternative control methodologies will be presented.

Keywords: Bananas, enhanced biodegradation, non-fumigant nematicides, *Radopholus similis*

Chemical and Mechanical Control of *Prosopis* sp. in Sudan

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Prosopis sp. is a perennial woody plant, characterised by a strong root system, and with the ability to grow under a wide range of environmental conditions. It was introduced into Sudan in 1917 and it plays a major role in stopping the desertification process. However, as its growth is difficult to control, *Prosopis* negatively affects Sudan's agricultural productivity. Therefore, Sudan has spent a huge amount of money in order to control its fast and wide spreading into agricultural lands and irrigation canals.

This study was carried out to control *Prosopis* sp. by using chemical (touch-down herbicides) and mechanical methods (burning of trees). The experiments were conducted in Shambat, Khartoum North. A complete randomized block design was applied with three treatments. Each treatment was repeated five times. In the first treatment, touch-down herbicide was injected between the stem and the root of each plant. In the second treatment the plant was completely burnt, and in the third one the plant was left as control. Records were taken every two weeks up to six months.

The results revealed that *Prosopis* sp. was highly affected by touch-down herbicides, the shoot system was completely destroyed, the stem became brown and there was no sign of plant growth. In the second treatment (burning), the shoot system and the stem were completely destroyed, however, after two months a new shoot system developed. These *Prosopis* trees doubled in size every two weeks.

It therefore can be concluded that touch-down herbicide must be used as a control method. However, given in mind the importance of organic control methods, research must be conducted to find biological control possibilities.

Keywords: Burning, *Prosopis* sp., touch-down herbicides

Soil Fertility and Nutrient Management in Asian Cropping Systems

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Phosphorus Adsorption Saturation of Synthetic Iron Oxides in Relation to Phosphorus Availability for Paddy Rice

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The characteristics of phosphorus (P) sorption/desorption of artificially synthesized iron oxides (ferrihydrate, goethite and hematite) and the relationship between P adsorption saturation of ferrihydrate and P uptake by rice were studied. The results obtained from experiments showed that P adsorption properties of three synthetic iron oxides could be described by the Langmuir equation with a correlation coefficient >0.9 at 1 % significant level. It was found by comparing Q_m (maximum quantity of adsorption), K (adsorption constant) and MBC (maximum buffering capacity) of three synthetic iron oxides that ferrihydrate (amorphous) was much larger than crystalline iron oxides (goethite and hematite) in both intensity and capacity of P adsorption. Phosphorus adsorbed by ferrihydrate was much more difficult to be desorbed than that absorbed by goethite and hematite. It could be found from P desorption curves that the corresponding quantities of P adsorbed by ferrihydrate, goethite and hematite for desorbed P reaching to 0.1 mg g⁻¹ were 28, 2.5 and 1.4 mg g⁻¹, respectively. However, when P desorption curves were changed to plot saturation of P adsorption (adsorbed P/Q_m*100) with P desorbed it was found that the corresponding saturation of P adsorption of three kinds of iron oxides for desorbed P reaching to 0.1 mg g⁻¹ was all about 70 %. This suggested that P adsorption saturation may be used as an integrative index for estimating the intensity and capacity of P adsorption-desorption in soils or iron oxides. A bioassay using rice indicated that P uptake by rice was significantly correlated to the saturation of P adsorbed by ferrihydrate and 50 % of P adsorption saturation could be used as a critical index for diagnosing status of P supplied by ferrihydrate-bonded P at the tillering stage of rice.

Keywords: Adsorption saturation, adsorption-desorption, iron oxides, P uptake, phosphorus

Effects of Nitrogen Levels and Nitrate/Ammonium Ratios on Oxalate Concentrations of Different Forms in Edible Parts of Spinach (*Spinach oleracea* L.)

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Two hydroponic experiments were carried out to investigate the effects of nitrogen levels and forms on the oxalate concentrations of different form in edible parts of spinach. Nitrogen was supplied at five levels (4, 8, 12, 16, 20 mM) in experiment 1 and five ratios of nitrate (NO_3^-) to ammonium (NH_4^+ ; 100/0, 75/25, 50/50, 25/75, 0/100) at a total N of 8 mM in experiment 2. Biomass of spinach increased markedly from 4 mM to 8 mM N but a plateau thereafter. The total oxalate and soluble oxalate in leaves and shoots (edible parts) increased significantly with increasing N levels from 4 to 12 mM, while the total oxalate and insoluble oxalate decreased markedly when N level was further increased from 12 to 20 mM. Oxalates of different forms in petioles increased first and then decreased and rose again with increasing nitrogen levels. In the second experiment, decreasing $\text{NO}_3^-/\text{NH}_4^+$ ratios markedly increased at first and then significantly decreased the biomass of spinach plants and the maximum biomass was recorded in the treatment of the $\text{NO}_3^-/\text{NH}_4^+$ ratio of 50/50. The oxalate concentrations of different form in leaves and shoots were all decreased obviously as the ratio of $\text{NO}_3^-/\text{NH}_4^+$ decreased from 100/0 to 0/100. Concentrations of total oxalate and soluble oxalate in petioles could be reduced by increasing the ammonium proportion and were the lowest as the ratio of $\text{NO}_3^-/\text{NH}_4^+$ was 50/50 and insoluble oxalate decreased with a decreasing nitrate/ammonium ratio. The concentrations of oxalate forms in leaves were all higher than those in petioles and soluble oxalate was the predominant form of oxalates in both trials. It is evident that high biomass of spinach can be achieved and oxalate concentrations of different forms can be reduced by modulating N levels and $\text{NO}_3^-/\text{NH}_4^+$ ratio. This finding is important especially for human nutrition of people with a history of calcium oxalate derived kidney stones.

Keywords: Human health, nitrate to ammonium ratio, nitrogen level, oxalate form, spinach

Vermicomposting in the Mekong Delta — Nutrient Fluxes and Sanitation of Vermicomposts from Different Substrates

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Farming systems with a small number of pigs or cattle are frequent in the Mekong Delta, Viet Nam where untreated manure is used as organic fertiliser. Because of sanitation concerns there is a need to treat the manure prior to field application. Composting in a hot rotting process is not possible if the amount of manure is low, therefore vermicomposting may be an alternative to treat smaller amounts of substrate. Vermicompost is used as a fertiliser and the earthworms may be used as a N rich feed. In a vermicomposting experiment carried out in Can Tho, Viet Nam, nutrient fluxes and sanitation process in three different substrates were studied.

Two hundred grams of *Eisenia fetida* were applied to 4,5 kg biogas sludge, cattle excrements and pig excrements. The composting process was monitored for two months. Worms and substrates were analysed on Kjeldahl-N, carbon, phosphorus, potassium and heavy metals at the beginning and the end of the experiments. Additionally, substrates were analysed on Coliformes, *E. coli*, *Salmonella* and Helminth eggs. During the composting process moisture content was controlled and adjusted to 85 % and pH, temperature and weight were monitored.

The data showed a significant reduction in the numbers of Coliformes, *E. coli*, *Salmonella* and Helminth eggs. Also, a significant decrease of the nutrient masses in the substrates caused by leaching was observed, but heavy metal concentrations remained unaffected. Although the number of worms was lower at the end of the experiment, a significant uptake of nutrients and heavy metals by the worms was observed. Nitrogen concentrations in the worm biomass increased significantly from 0,01 g N/g DM in the biogas sludge to 0,08 g N/ DM and in both excrements to 0,10 g N/g DM. Only vermicomposting of pig excrements caused significant nitrogen losses (12 %).

The sanitation effect by vermicomposting seem to be similar than by hot rotting. But vermicomposting causes lower nitrogen losses and it produces a highly valuable product (worms) that can be sold as feed.

Keywords: Biogas sludge, cattle excrements, *Eisenia fetida*, Mekong Delta, nutrient fluxes, pig excrements, sanitation, vermicompost, Viet Nam

Aerobic Pre-Treatment of Municipal Solid Waste to Prevent Pollution by Landfill Leachates

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In developing countries municipal solid waste (MSW) is either dumped or landfilled without prior treatment. As a consequence, agricultural production is negatively affected by hazardous leachate in the surroundings of the landfill. A biological pre-treatment of municipal solid waste reduces methane emissions and leachate from landfills. In Can Tho (South Viet Nam) leather is manufactured and the waste is landfilled, too. As a consequence, the leachate may contain heavy metals (chrome), high loads of organic compounds and ammonium. We tested a simple method to pre-treat municipal solid waste with leather waste to adapt this system to tropical conditions. Two hundred litres (ca. 80 kg) of municipal solid waste (with/without leather waste) was aerated in isolated small windrows. During the first six weeks the material was mixed, and moistened if necessary, weekly, later on every second week.

After a short lag phase, the temperature in the windrows was higher than 60°C for ca. four weeks. Then the temperatures decreased slowly and after three months they adapted to ambient temperature. During the treatment only small amounts of methane and nitrous oxide were produced. The oxygen consumption, an indicator for microbial stability of the substrate, decreased from 58.4 mg O₂ g⁻¹ DM for MSW at the beginning of the experiments to 3.6 mg O₂ g⁻¹ DM at the end of the incubation. MSW mixed with leather waste showed similar rates of oxygen depletion indicating that the treatment is sufficient to produce a stabilised waste and to reduce the risk for agricultural production next to the landfills.

Keywords: Composting, waste

Managing Rice-Wheat Cropping Systems of Nepal for a More Efficient Soil N Use

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The rice-wheat annual double cropping system occupies an estimated 0.5 million hectares in Nepal where it provides food for about 23 million people. The production systems are similar regarding soil type and agronomic management but differ in terms of the climatic environment, stretching from subtropical lowlands to temperate mountain areas. Current production is far below the reported potential, with N-deficiency being the major constraint. Subsistence-oriented smallholder agriculture limits the use of mineral fertiliser and crops have to rely largely on native soil supply for their N nutrition. Between the harvest of winter season wheat and the transplanting of monsoon season rice lies a transition season of variable length (>10 weeks in the lowlands to <5 weeks in the mountains) where the land is typically under bare fallow. During this dry-to-wet season transition period (DWT), the soil aeration status changes from aerobic to anaerobic, resulting in an initial peak of soil N mineralisation and its subsequent disappearance upon soil flooding. Protecting this native soil N from being lost is seen to improve the N nutrition of crops and the currently negative N balances with impact on productivity.

Possible options may include the temporary immobilisation of soil N in the biomass of soil microorganisms and/or of transition season crops. The choice of suitable crops and management options depends on site conditions. Particularly the thermal environment will determine the duration of the vegetative growth phase of the cereals and hence influence the length of DWT available for the cultivation of transition season crops. On the other hand, integration of promising “new” crop species to build soil fertility and generate food and income may offset the existing cropping calendar, pushing the critical growth stages of rice in periods with extreme climatic events and/or result in conflicts of labour time allocation.

A DFG/BMZ-funded collaborative research project between the universities of Bonn and Rampur and the Nepal Agricultural Research Council studied the extent and the processes of soil N transformation, technical options for N conservation and phenological characteristics of cultivars to fit the agronomic calendars of the new cropping systems.

Keywords: *Mucuna*, *Oryza sativa*, *Triticum aestivum*, *Vigna radiata*, wheat straw, *Zea mays*

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Wheat Straw Application Can Reduce N Losses from Rice-Wheat Cropping Systems in Nepal

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Long-term cropping experiments in South Asia indicate declining yield trends in rice-wheat rotations. Particularly under conditions of low external input use, this yield decline is linked to N deficiency and to soil N losses that occur mainly between the harvest of wheat and the transplanting of monsoon season rice. Improved management options must target this dry-to-wet-season transition period (DWT) to effectively control N losses. In the high altitude sites of the Himalayas, this DWT during which the soil aeration status changes from aerobic to anaerobic is too short to grow any crops and the only available option to protect mineral soil N from losses is its temporary immobilisation in the microbial biomass after application of low-quality crop residues (wheat straw). Experiments were conducted in potted soil in the greenhouse and under field conditions at Lumle (Karsi province, 1700 m asl) to study the effect of wheat straw at different application rates (0, 1.5 and 3 Mg ha⁻¹) and methods (mulching vs. incorporation) on soil N dynamics and rice response. In the bare fallow (farmers' practice), a gradual increase in soil moisture resulted in a build-up of 48 kg ha⁻¹ of soil NO₃-N, which declined to <1 kg upon soil flooding. This decline was associated with nitrate leaching (14 kg ha⁻¹) and a peak in nitrous oxide emissions (11 mmol N₂O m⁻²). Straw application reduced the soil nitrate-N peak to 18–33 kg ha⁻¹, with a parallel increase in soil microbial biomass N, a 20–35 % reduction in the emission of nitrous oxide, and a 50 % reduction in nitrate leaching compared to the bare fallow. The effectiveness of wheat straw in conserving soil N, building soil organic matter and increasing N uptake and the yield of rice increased with straw application rate and the length of the transition season, and tended to be more with straw incorporation than with surface mulching. In areas where wheat straw is no tradable commodity (animal bedding, fuel), it may present a valuable resource to reduce native soil N losses during the relatively short DWT in rice-wheat systems of higher altitudes and increase the yield of rice and possibly of wheat.

Keywords: Denitrification, nitrate leaching, *Oryza sativa*, *Triticum aestivum*

Nitrogen Losses by Erosion and Leaching in Hillside Cropping Systems of Northeast Thailand as Affected by Soil Conservation Measures: A Case Study

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In Northeast Thailand, soil erosion by water is a severe problem in uplands. High amounts of fertiliser are required to compensate for nutrient losses by runoff and to mitigate soil degradation. Nitrogen losses by soil erosion are main contributors to environmental problems. Both, applying integrated soil conservation systems as well as studying the dynamics of nitrogen losses are needed to provide sustainable agriculture. The objectives of this study were to assess (i) nitrogen losses by erosion and leaching in hillside cropping systems and (ii) effects of soil conservation measures on these losses. Data were collected from an erosion trial on a clayey, kaolinitic, typic Papluslox during 2003 and 2004 at Ban Bo Muang Noi, Northeast Thailand, with slope gradients ranging from 18–25 %. The field trial was established in a split plot design with two replicates. Two fertiliser levels (no fertiliser and 61 kg of N and 14 kg P ha⁻¹) were applied in the main plots, while four soil conservation measures with maize and a control were established in the subplots. The treatments were (i) farmers' practice, (ii) vetiver grass strips, (iii) mango-grass hedges, (iv) leucaena hedges and (v) papaya-grass hedges. Soil loss in the farmers' practice was significantly higher than in all other treatments and amounted to 20.4 t ha⁻¹ yr⁻¹. The lowest soil loss was observed with papaya-grass hedges with less than 5.4 t ha⁻¹ yr⁻¹. Runoff losses did not differ significantly among treatments, but tended to decrease when soil conservation measures were applied. Comparing leaching and soil losses showed that leaching was the main pathway of N losses. N losses by erosion accounted for only 9–32 % of the total N losses, whereas leaching accounted for 68 to 91 %. In soil conservation treatments, however, leaching losses were 12 % higher compared to the farmers' control. In conclusion, soil conservation measures involving papaya-grass barriers controlled soil loss, runoff and nitrogen loss by erosion in maize effectively, but led to higher N losses via leaching due to an increased infiltration rate when compared to farmers' practice.

Keywords: Agroforestry, erosion, fertiliser application, fruit trees, leaching, maize, N losses, runoff, ruzi grass, soil conservation, soil loss, vetiver grass

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Yield Gaps, P and K Balances and Soil Changes in Irrigated, Rice-Based Cropping Systems on Degraded Soils in the Red River Delta of Viet Nam

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Alerted by reports about stagnating or even declining yields in rice-based cropping systems across Asia, we analysed yield gaps, P and K balances and soil nutrient changes in a continuous cropping experiment on a low-fertile Acrisol in the Red River Delta of Viet Nam. The trial included three cropping systems (rice—soybean—rice, soybean—rice—maize, and rice—rice—maize) and 7 treatments comprised of various combinations of N, P and K and farmyard manure (FYM). The application of recommended NPK fertiliser rates resulted in average yield levels of 3.8 Mg ha⁻¹ for rice and maize, and 1.2 Mg ha⁻¹ for soybean. The complementary application of 10 t FYM ha⁻¹ yr⁻¹ increased average yields by about 11 % in rice and 22 % in upland crops and maintained the soil carbon content that largely governs cation exchange processes in degraded soils with low clay content. In nutrient omission plots, soil reserves were quickly depleted, irrespective of the cropping system.

The annual P balance was positive (21 to 55 kg P ha⁻¹ yr⁻¹) in all cropping systems with recommended fertiliser application rates. The omission of P resulted in negative overall balances of -29 to -35 kg P ha⁻¹ yr⁻¹ and Olsen P soil contents declined by 32 to 55 % over the 6-yr experimental period. The soil exchangeable K on the other hand declined from initially 0.22 to 0.02 cmol kg⁻¹ within the same period. Despite annual K balances ranging from -39 to 37 kg K ha⁻¹ yr⁻¹, soil exchangeable K declined by 63 to 81 % in the NPK treatment. This strong K limitation resulted in yield gaps that ranged from 1.2 to 2.2 Mg ha⁻¹ in rice depending on season, while it averaged 0.9 Mg ha⁻¹ in soybean and 3.4 Mg ha⁻¹ in maize. We conclude that K is the nutrient element most limiting continuous crop production in the intensively used systems on degraded soils in the Red River Delta. Apart from K, the application of farmyard manure and secondary nutrient elements (Mg, Zn) is seen to be required for sustained yield levels and a balanced nutrient supply in the long term.

Keywords: Acrisol, *Glycine max*, long-term experiment, *Oryza sativa*, *Zea mays*

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Soil and Crop Management During the Transition Season Improves N Balance and Productivity of Rice-Wheat Cropping Systems in Nepal

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Under the prevailing low-input production conditions of Nepal a low productivity of rice-wheat rotations is generally associated with highly negative N balances. Previous work indicates that massive soil N losses during the dry-to-wet season transition period between wheat harvesting and rice transplanting may be responsible for the reported declining yield trends in the traditional production systems. A range of management practices, aimed at the conservation and/or replenishment of soil N during the transition season, were evaluated regarding year-round dynamics of soil N (mineralisation, nitrate leaching, nitrous oxide emissions), crop N assimilation (uptake, nitrogen fixation), cumulative grain yield (wheat + rice) and systems' N balances. Experiments were conducted on station and in several farmers' fields of the Terai region in Nepal between 2001 and 2004. In the traditional production system (bare or weedy fallow during the transition season), the occurrence of a distinct mineralisation peak at the onset of the rainy season was associated with losses of some $40 \text{ kg N ha}^{-1} \text{ yr}^{-1}$, a cumulative grain yield of $2.8 \text{ Mg ha}^{-1} \text{ yr}^{-1}$ (rice + wheat) and a N balance of $-78 \text{ kg N ha}^{-1} \text{ yr}^{-1}$. Application of wheat straw, sole or in combination with various nitrogen-fixing and non-fixing transition season crops significantly reduced N losses compared to a bare fallow transition season field management and increased the cumulative grain yield to $3.1\text{--}5.4 \text{ Mg ha}^{-1} \text{ yr}^{-1}$. While increasing the short-term grain production, the use of non-fixing transition season crops resulted in the most negative N balance of up to $-93 \text{ kg N ha}^{-1} \text{ yr}^{-1}$, indicating a possible long-term aggravation of the declining yield trends. Combining a temporary N immobilisation in the soil microbial biomass through straw incorporation with soil N uptake and atmospheric N assimilation by green manure legumes minimised soil N losses, provided a cumulative grain yield of $>5 \text{ Mg ha}^{-1}$ and showed near-neutral N balances. Implications for long-term systems management will be discussed.

Keywords: Green manure legumes, N assimilation, N balance, nitrogen fixation

Biogas Sludge Reduces Aluminium Toxicity and Improves Tubers Performance on Acid Sulphate Soil of the Mekong Delta

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In the rice-based systems of the Mekong Delta in Viet Nam, there is a trend towards replacing the traditional rice double cropping with a rotation of wet season rice and dry season upland crops (vegetables and tuber crops). However, in the prevailing acid sulphate soils, the build-up of excessive concentrations of exchangeable aluminium (Al^{3+}) during the aerobic soil phase is strongly limiting upland cropping to few relatively Al-tolerant tuber crops that farmers grow on raised beds to enhance Al^{3+} leaching process. The use of organic amendments can reportedly increase soil pH and plant available P, while decreasing the concentration of active Al^{3+} throughout the formation of non-toxic Al-DOM complexes or the formation of humic complexes with Al and Fe. This research studied the performance of major tuber crops (cassava, sweet potato and yam) in relation to soil exchangeable Al^{3+} concentration and as affected by the application of locally produced biogas sludge. Experiments were conducted on three farmers' fields at the Hoa An research station of the University of Cantho, Viet Nam on a typical acid sulphate soil. Observation plots were laid out on raised beds and were categorised based on the initial exchangeable Al^{3+} content of the top-soil in classes of <10, 10–15, and >15 meq Al^{3+} 100^{-1} g. Biogas sludge was applied at 3 Mg ha^{-1} (dry matter) to tuber crops and compared with an unamended control. Soil total acidity and exchangeable Al^{3+} were determined from KCl extracts after subsequent NaOH and NaF titration, respectively. Dry biomass accumulation, tuber yield, and nutrient uptake by 12-week-old crops were compared. Biogas sludge tended to reduce soil exchangeable Al^{3+} concentrations but significantly increased the tolerance to given Al concentrations with higher tuber yield and P uptake in all tuber crops. However, Al-tolerant cassava showed stronger responses to amendment than Al-sensitive yam. We conclude that in the absence of soil liming, the application of organic wastes can improve the performance of Al-tolerant while permitting the cultivation of more Al-sensitive crop on acid sulphate soils. Further research aims at identifying most appropriate substrate types and application rates for specific acid soil conditions and crop tolerance levels.

Keywords: Active aluminium, *Dioscorea* sp., *Ipomoea patatas*, *Manihot esculenta*, *Oryza sativa*, Viet Nam

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Improving Potassium Use Efficiency in Rice-Based Cropping Systems on Degraded Soils in the Red River Delta of Viet Nam

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Rice (*Oryza sativa* L.) is the staple in the North of Viet Nam and is cultivated in two distinct seasons that differ in climatic yield potential. In this 2-year study, we focused on the rice—rice—maize rotation, which is the most widespread cropping system in the Red River Delta, one of the most intensively cultivated agricultural areas in the world. We investigated opportunities to increase K use efficiency on a low-fertile Acrisol that is characterised by strong K limitations and a low CEC.

In the spring season, lowland rice yields ranged from 4.8 to 5.2 Mg ha⁻¹ irrespective of K fertiliser rates, the K splitting pattern or the application of farmyard manure or crop residues. Despite small K soil reserves, the highest grain yields were obtained when rice solely relied on residual fertiliser K, soil supply and K inputs through the irrigation water. When fertiliser K was applied, we determined very unfavourable K/Mg ratios in the plant tissue during crucial development stages of rice. This may have prevented a further yield increase despite a large increase in total K plant uptake that ranged from about 40 kg ha⁻¹ when K was omitted to 130 kg ha⁻¹ when recommended fertiliser rates were supplemented with farmyard manure.

During the summer season that is characterised by a lower yield potential, the splitting of recommended K fertiliser rates (50 % at 15 days after transplanting, 50 % before panicle initiation) significantly increased the grain yield of lowland rice by 12 % over the basal application and by 18 % over the unamended control. The average yield levels were 3.6 and 3.3 Mg ha⁻¹ with and without the application of farmyard manure, respectively. The incorporation of rice straw that added 40 to 60 kg K ha⁻¹ to the system only increased rice yields without the additional application of fertiliser K. It appeared that the K flush resulting from the quick solubilisation of K in the straw was largely lost by leaching due to the low K requirements during the early growth stages of rice and the poor K retention by the low CEC.

Keywords: Acrisol, K/Mg ratios, leaching, *Oryza sativa*, split application, straw incorporation

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Smallholder Maize Productivity under Alternative Soil Fertility Management Options in Malawi

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This contribution focuses on smallholder maize production in Malawi by investigating the link between productivity and soil fertility management. Many studies conducted on Malawi indicate declining levels of maize productivity that pose serious food security concerns, since maize is the staple crop in most areas of the country. In this paper, we analyse the factors influencing productivity of maize among smallholder farmers, especially given the fears that unfavourable output and input market conditions throughout the 1990s may have compelled smallholder farmers into unsustainable agricultural intensification. Farm-household survey data is analysed in order to compare the productivity of smallholder maize production under integrated (ISFM) and chemical-based soil fertility management. A normalised translog yield response model is estimated by imposing monotonicity and curvature correctness at the sample mean. The results indicate higher maize yield responses for integrated soil fertility management options, after controlling for the intensity of fertiliser application, labour intensity, the seed rate as well as land husbandry practices and policy factors. The estimated model is highly consistent with theoretical regularity conditions. Thus we conclude that the use of ISFM increases the productivity of maize production in comparison to the use of inorganic fertilisers. Since most farmers in the maize-based farming systems are crowded out of the agricultural input market and can hardly afford optimal quantities of inorganic fertiliser, enhancement of ISFM is likely to enhance their maize productivity. In terms of policy implications, ISFM provides scope for improving maize productivity especially where use of inorganic fertiliser is highly unaffordable and risky. Thus there is need for policy interventions to promote smallholder uptake of ISFM options. Finally areas of policy support are identified to enhance ISFM uptake in smallholder maize-based farming systems.

Keywords: Malawi, normalized translog yield response model, smallholder agriculture, soil fertility management

Linking Ecological Sanitation and Agriculture in Sub-Saharan Africa

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The poster illustrates first findings of the interdisciplinary research project “Potentials and Constraints to the Link of Urban Agriculture and Ecological Sanitation” carried out at Hamburg University of Technology. A vital part of the studies is the investigation of the safe reuse of faeces and urine in agriculture and the social acceptability of re-circulation of human-derived nutrients.

By 2020, the number of people living in developing countries will grow from 4.9 billion to 6.8 billion. Ninety percent of this increase will be in rapidly expanding cities and towns. Growth in urban poverty, food insecurity, and malnutrition will accompany urbanisation. Severe environmental degradation and hygienic problems caused by the lack of infrastructure are additional problems. The linking of urban and peri-urban agriculture and ecological sanitation, in short UPA-Ecosan-Concept, could play an important role for the solution of the mentioned problems. Agriculture within city limits, so-called urban agriculture, became a survival strategy for many poor families in the last decades. These families would not be able to secure their nutrition without urban agriculture. This form of agriculture can be a vehicle to increase food security and health, to generate economic opportunities for people with low income, and to promote recycling of waste and wastewater. The philosophy of Ecosan is based on the consequent implementation of the “closing the loop approach” (nutrient cycling). Urine and faeces are regarded as resources to be used as fertiliser respectively as soil conditioner.

Hence linking Ecosan with agriculture, in particular urban agriculture is crucial for the sustainability of both Ecosan and agriculture and will be essential for the achievement of the Millennium Development Goals. Different from urban areas, the scarcity of land is not the most pressing problem in rural areas. Loss in soil fertility, environmental degradation, scarce water sources, and lacking hygiene are problems common in rural and urban areas. The study aims at introducing the concept of ecological sanitation to people involved in agriculture, to evaluate the potentials and constraints of the concept, and to discuss and learn from existing experiences, failures and success in different cultural, political, and economic environments.

Keywords: Ecosan, hygiene, socio-economics, Sub-Saharan Africa, urban agriculture

The Interaction Between Arbuscular Mycorrhizal Fungi, *Rhizobium meliloti* and *Bacillus circulans* on *Trigonella foenum-graecum* L. in a Calcareous Soil

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Two field experiments were carried out during two winter seasons of 2002–2003 and 2003–2004 at the Farm of Nubaria, Agriculture Research Station, Egypt. *Trigonella* seeds were inoculated with *Rhizobium meliloti*, *Glomus etunicatum* and biological potassium fertilizer (BPF) *Bacillus circulans* as a single inoculant or mixed in the presence of different levels of NPK mineral fertilizers. Nitrogen fertilizer was added at different levels in the case of *Rhizobium* inoculation. Recommended dose for both phosphorus and potassium fertilizers were used. Phosphorus fertilizer was added at different levels in the case of inoculating the seeds with *G. etunicatum*. Nitrogen and potassium fertilizers were applied at the recommended dose (N=240, P=480 and K=240 kg ha⁻¹).

Potassium fertilizer was used at different levels in the case of inoculating the seeds with *B. circulans*. Nitrogen and phosphorus fertilizers were used at the recommended dose.

NPK fertilizers were added at different levels in the case of using mixed inoculation.

The experiments were arranged as split plot design in randomized complete blocks with four replicates. Main plot was mineral fertilizer treatments and subplots were the inoculations. Growth parameters, yield and protein content in *Trigonella* seeds were studied in calcareous soil.

Inoculated plants with *Rhizobium* or *G. etunicatum* increased the yield of *Trigonella* 2–4 % above those of the non-inoculated plants in the presence of 75 and 50 % of the recommended dose of nitrogen and phosphorus fertilizers, respectively. Mixed inoculation with *Rhizobium*, *Glomus* and *Bacillus* had the highest seed yield (1779 kg ha⁻¹) in the presence of 75 % of the mineral NPK fertilizers recommended.

Percentage of protein content in seeds were not significantly increased due to the inoculations.

NPK uptake (kg ha⁻¹) were significantly increased in the presence of mixed inoculations using 75 % of the recommended dose. Generally, in case of seeds inoculation with *Rhizobium* or *Bacillus* separately, 25 % of mineral fertilizers of N or K were saved, while inoculating seeds with *G. etunicatum* can save 50 % of the phosphorus fertilizer. Mixed inoculations can save 25% of the NPK mineral fertilizers.

Keywords: *Bacillus circulans*, calcareous soil, Fenugreek seeds, *Glomus etunicatum*, NPK fertilizers, *Rhizobium meliloti*

Residual Effect of Composted Farmyard Manure on Sorghum Growth and Yield

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In Sudan *Sorghum bicolor* L. (Moench) is a staple food crop for more than 75 % of the population. It is annually grown on 6 million ha with an average grain yield hardly exceeding 0.5 t ha⁻¹. At the farm level, sorghum straw is used as animal fodder and fertilisers (synthetic or organic) are rarely used for this crop.

The experiment described here was conducted at the Gezira Research Farm in Wad Medani, Sudan, during the two seasons 2002 and 2003, to investigate the residual effect of farmyard manure (FYM) after application to muskmelon (*Cucumis melo* ssp *melo* var. *reticulatus*, "Gallia") on grain and stover yield of *S. bicolor*, variety Tabat. The experimental site in Gezira is characterised by a pH (water) of 8.2, an ECe of 0.4 dS m⁻¹ and an ESP of 11.1. It is a very heavy soil containing 0.3 % of organic matter, 59 % of clay, 29 % of silt and 12 % of sand, which is the reason for its low hydraulic conductivity of 0.9 cm h⁻¹. The experiment was laid out in a randomised complete block design replicated three times, with harvest areas of 4 m × 5 m. Treatments were 0, 2.5, 5 and 7.5 t of composted FYM ha⁻¹ which were incorporated on ridges with distances of 80 cm for the preceding crop muskmelon. During both seasons, sorghum was sown mid July at 20 cm intra row spacing and thinned to 2 seedlings per hill at 3 weeks after emergence. Urea was split applied at 84 kg N ha⁻¹, the first half after thinning and the second one month later.

The combined result of the two years showed that the FYM increased sorghum yield parameters: At 5 t FYM ha⁻¹, sorghum grain yield increased by 16 % and grain number per unit area by 20 %. At 7.5 t FYM ha⁻¹, biomass of sorghum increased by 19 %. Harvest index, number of days to 50 % flowering, plant height, panicle length and 100 grain mass were not affected. The positive influences of FYM are probably due to improved physical soil conditions (e.g. better permeability) of this heavy soil.

Keywords: Farmyard manure, muskmelon, sorghum, Sudan

Importance of Soil Microbial Activity to Explain Legume-Rotation Effects on West African Soils

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Incubation experiments (20 days with 9 extraction times) with continuous (M) versus rotation (R) nutrient-poor soils from Fada-Kouaré (F), Burkina Faso and Koukombo (K), Togo were conducted to investigate the effects of rewetting on soil chemical (pH) and soil microbial properties (respiration, adenylates, AEC, ergosterol). Artificial rewetting of the dry soil thereby aimed at simulating the onset of the rainy season after a long period of drought stress. PH values remained largely unaffected by rewetting and were 6.1 for KM, 6.2 for KR, 6.3 for FM and 6.3 to 6.7 for FR with a wider range for the Fada soils. Respiration after rewetting reflected the common initial flush of CO₂-C (FM = 22.6 μg g*d⁻¹; FR = 37.1 μg g*d⁻¹; KM = 10.6 μg g*d⁻¹; KR = 13.9 μg g*d⁻¹) with a subsequent rapid decrease to values ranging from 0.6 to 8.1 μg g*d⁻¹ CO₂-C. Ergosterol concentrations with a maximum of 0.67 μg g⁻¹ (FR) soil and ATP concentrations with a maximum 0.69 μg g⁻¹ soil were very low. Adenylate energy charge (AEC) indicated dominantly dormant cells (< 0.8) but during the second wetting cycle AEC > 0.8 were found in FM and FR indicating the effects of cell growth.

Low respiration levels, high AEC and increasing ATP concentrations indicated that the microbial cells were at a stationary 'metabolic alertness' to capture nutrients as a consequence of the rewetting-induced mineralisation. Partially retained activity in certain fractions of the cell's transcriptional resources might rather be due to growth mechanisms than survival strategies.

Overall the results showed significant site and system specific effects, thereby backing the expectation of specific microbial populations being part of the mechanisms of yield enhancing legume effects in cereal-legume rotations on West African soils.

Keywords: Adenylate energy charge, ATP, enhanced cereal production, microbial survival, respiration, rewetting

Effects of Production Systems with Maize (*Zea mays* L.) on Soil Fertility and Biological Diversity in Soconusco, Chiapas, Mexico

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The abuse of chemical products in the production systems in the Central American tropical region has caused a series of drastical effects on natural resources. The deterioration of such destroy sustainable production possibilities and depends on high external inputs, mainly fertilisers and pesticides. The objective of this research was to analyse bases for the implementation of sustainable agriculture practices and to enhance the sustainability of agricultural maize production systems in Chiapas. The investigation was carried out during cropping cycle 2002–2003 in the region of the Soconusco, Chiapas, Mexico. Four treatments with experimental areas of one hectare each were selected: **(i)** a production system with maize (roza-tumba-quema) with 2 years cropping; **(ii)** a production system with 6 years monoculture maize; **(iii)** a production system with 12 years monoculture maize; **(iv)** an area with tropical rain-forest.

In each experimental unit were determined the physical and chemical soil properties, the dynamic of weed populations and the system's productivity. An one way experimental design was used, with seven levels, and four repetitions. The collected data indicates that the content of organic C, N total, and interchangeable K, Ca and Mg, strongly declined with the duration of maize cultivation. The lowest values presented the maize treatment with 12 years of monoculture, whereas the treatment with 2 years maize cropping had soil values very similar to the tropical rain-forest. Opposite, the P increased in the systems with maize. The weed biomass decrease with maize cropping duration, showing the highest biomass production in the treatment with 2 years of maize cropping. The diversity of weeds also decreased by maize cropping duration. The treatment with 2 years maize cropping had 20 weed species followed by the 6 years maize monoculture with 17 weed species and the treatment 12 years monoculture present only 12 weed species. Maize yield ranged between 4353 kg ha⁻¹ with 2 years maize cropping and 1785 kg ha⁻¹ with 12 years of maize monoculture.

Keywords: Maize, production systems, soil fertility, weed biomass, weed diversity

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A Survey of Urban and Peri-Urban Agriculture in Niamey, Niger

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Urban and peri-urban agriculture (UPA) contributes significantly to urban food security and income generation in developing countries. In spring 2004, a survey was conducted in Niamey, Niger based on structured semi-quantitative interviews. Major UPA crop and livestock activities were characterised for 130 households distributed evenly across 13 city quarters which were selected from a satellite-based map of gardens and fields within and around the city. Samples of irrigation water, manure and fodder were collected and analysed for concentrations of nitrogen (N), phosphorus (P) and potassium (K).

Animal husbandry, irrigated vegetable production and rain-fed millet cropping was practised by 82 %, 42 % and 58 % of the interviewed households, respectively. Sheep were kept by 74 % of livestock keeping households, followed by cattle (54 %) and goats (29 %). Cattle were usually herded on pastures around the city, sheep and goats were preferably kept in the courtyard. Meat, milk and manure were major products of livestock activities, whereby livestock keepers identified fodder shortages as the prime limiting production factor.

Irrigated vegetable gardens were mainly located near surface water sources within the city, especially near the river Niger (900 ha) and a wastewater stream (50 ha). A wide variety of vegetables was cultivated during two to three yearly cropping cycles. Vegetable plots were mainly fertilised with manure from gardeners' own animals or with purchased manure. The application of wastewater also provided substantial amounts of nutrients, namely 104 mg N, 7.5 mg P and 98 mg K per litre of water. Pearl millet, usually relay-cropped with cowpea, was cultivated outside the built-up areas. Although some farmers applied animal manure, nutrient inputs to UPA millet fields were not distinctly different from inputs to millet fields in the rural hinterland.

The survey highlighted the interactions between different UPA production sectors, especially the multiple directions of nutrient relocation through manure and livestock feed. Although these nutrient transfers need further quantification, it appears that nutrient inflows from external sources, such as purchased livestock feed and human food, contribute substantially to the nutrient supply for UPA cropping activities.

Keywords: Crop and livestock activities, Niger, nutrient transfers, urban agriculture

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A Rapid Bio-Test to Study the Activity Potential of Biofertilisers Based on *Trichoderma* sp.

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Bio-effectors based on plant-growth-promoting soil microorganisms are increasingly distributed on the European market and particularly in the tropics. Mobilisation of sparingly available plant mineral nutrients, stimulation of root growth, enhanced resistance to environmental stress factors and direct or indirect suppression of plant pathogens and induced resistance are discussed as possible mechanisms for the effectiveness of these products. However, these assumptions are based only on scarce scientific evidence which is further absured by a lack of standards for production and quality control. Therefore, rapid screening tests to evaluate the potential effectiveness of a given product, prior to more detailed and labourious investigations are urgently needed. In this study, a rapid bio-test with cucumber (*Cucumis sativa*) as an indicator plant was developed to evaluate the effectiveness of four commercial bio-effectors based on *Trichoderma* sp. (Biohealth-G, Biohealth-WSG, Biomex and Vitalin T50) using germination rate, root and shoot biomass, root length, and leaf area as test parameters. The experiment was repeated twice with 6 replicates in hydroponics culture under controlled conditions (pH 5.5, 22° C; Light: 230 mmol cm² sec⁻¹). Biofertilisers were applied at the rate of 3g/2.5 l pot. Germination increased by 40–50 % in all biofertiliser treatments compared to the control. After 2 weeks culture period, root dry weight and leaf area of Biohealth-G, Vitalin T50 and Biomex-treated cucumber seedlings were significantly increased. Biohealth-G and Vitalin T50 showed significantly higher root length and Biohealth-G higher shoot dry weight than the remaining treatments, while Biohealth-WSG did not cause differences compared to untreated control plants. The pathogen-antagonistic potential of *Trichoderma* strains can be easily tested by co-inoculation with *Gaeumannomyces graminis* on malt extract peptone agar plates. The results suggested that the activity potential of different *Trichoderma*-based biofertilisers could be easily screened by using the described bio-test with cucumber seedlings.

Keywords: Biofertiliser, *Cucumis sativa*, hydroponics, *Trichoderma* sp.

Nutrient Management in a Low Input Production System of Syria

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Reconciling the need for more production with ever decreasing resources is the main challenge for agricultural research in low-input systems such as those found in Khanasser valley in the North Western Syria. Over-exploitation of limited land and water resources for the production of barley for sheep fattening is combined with an unfavourable biophysical environment characterised by drought, salinity and a low availability of P and Zn resulting from the high pH of the prevailing Calcisols. Shortage of information on resources flows and inefficient resource use further exacerbate the production conditions for the rural population.

Technologies that are based on locally available resources (i.e., farmyard manure) and with a low dependence on purchased inputs (mineral fertilisers) need to address the dominant constraints of drought and P-Zn deficiencies and to assist in the development of site-specific nutrient management systems in these marginal environments. We evaluated nutrient fluxes, the availability of soil nutrients in relation to soil moisture, and the barley response to organic and mineral inputs along cross sections of Khanasser valley and tested promising technical options with local farm communities to develop site-specific solutions.

While mineral P fertiliser improved crop production mainly under the favourable on-station conditions, application of manure showed the highest efficiency on on-farm. Seed priming with P/Zn-solution exhibited superior barley establishment and increased yields by reducing P/Zn deficiencies and enhancing the crops drought tolerance in the marginal on-farm environment. Nutrients and soil moisture were higher close to the valley side, where surface on-flow water is amplified and they decreased with distance from the slopes. The possibilities and limitations of site-specific targeting of technical options will be discussed.

Keywords: Animal manure, *Hordeum vulgare*, nutrient management, phosphorus, seed priming, zinc

Agroforestry: Methodology and Ecology

FESTUS K. AKINNIFESI, CORI HAM, DANIE JOORDAN, MYLES MANDER, DAGMAR MITHÖFER, TUNU RAMADHANI, F. KWE-SIGA, JOHN SAKA, SOLA PHOSISO: Building Opportunities for Small Holder Farmers to Commoditize Indigenous Fruit Trees and Products in Southern Africa: Processing, Rural Pilot Enterprises and Marketing	310
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Building Opportunities for Small Holder Farmers to Commoditize Indigenous Fruit Trees and Products in Southern Africa: Processing, Rural Pilot Enterprises and Marketing

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Tree products, especially indigenous fruits products provide avenues for millions of smallholder farmers to improve their livelihoods in developing countries. This paper synthesizes our research and development experiences in understanding market constraints and opportunities, potential impacts of fresh fruits, and feasibilities of rural enterprises to set up pilot sites in four countries (Malawi, Zambia, Zimbabwe and Tanzania). The domestic market opportunities and strategies for smallholder farmers and forest dwellers to commercialise indigenous fruit trees (IFTs) were explored along the entire supply chain — production, marketing and utilisation. Experience on processing and enterprise development ventures by rural women groups are analysed. Product prioritisation with stakeholders showed that preference of rural processors varied between countries depending on the markets and the availability of raw materials. Feasibility assessments of pilot enterprises reveal that the development of partnerships between producer community and private entrepreneurs is critical. Product viability varied between countries. The Zimbabwe fruit jam and bars enterprise was viable, and it has potential to spread its risks across local and export markets, but investment was largely threatened by unstable economy, and must hedge against imported costs. The Malawi jam and juice concentrates enterprise was also viable and is a key opportunity for import substitution with regard to imported fruit juice concentrates, provided that the local consumer market is known. A large market share (29 %) is expected to be replaced by local production, and breakeven volume is 76 t. Efficient input, processing and distribution networks need to be in place within constraints of the developing economy. The results suggest that the most promising opportunity for rural processors of indigenous fruits, is to focus on the local markets of fruit concentrates as an export substitute. Establishment of partnerships between producer communities and private entrepreneurs is essential. Holistic farm plans are needed to promote cultivation, to ensure product quality and to maximise competitiveness at the farm gate and throughout the supply chain.

Keywords: Feasibility assessment, impact assessment, fruits, marketing, food processing

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Conversion Process and Reforestation Practices of Coffee Plantations in Chiapas, Mexico

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The Soconusco is considered the heart of coffee production in Mexico and belongs to the Mesoamerican coffee belt. The coffee agro-ecosystems are undergoing a thorough transformation process, although insufficiently documented as yet. In this study, different aspects of a gradual conversion process from coffee to timber production were evaluated, with the aim to understand, how the agro-ecosystem coffee changes in horizontal and vertical structure, in terms of biomass components, and which ecological conditions are prevailing in this process. The field study was carried out between 2003 and 2005 in five different farms in the Soconusco, within which 17 experimental areas were identified in an altitudinal range from 400 to 1000 m asl and combined with different expositions to the sun. Dry biomass assessment was carried out in four different components: coffee plants, shade trees, timber trees as well as soil cover and litter (sub-divided into fine, coarse, monocotyledonae, dicotyledonae). After measuring height and basal area, biomass components were calculated for both timber trees and coffee plants, using allometric equations. Destructive sampling was used for shade trees, soil cover plants and litter. Plant species diversity was determined and the ten most important species for commercial timber production were identified (*Acrocarpus fraxinifolius*, *Cedrela odorata*, *Colubrina arborescens*, *Cordia alliodora*, *Melia azederach*, *Ocotea* spp., *Swietenia macrophylla*, *Tabebuia donnell smithii*, *Tabebuia rosea*, *Tectona grandis*). The coffee agroforestry systems have between 1279 and 3978 coffee plants ha⁻¹. The study shows that total basal area and its partitioning among vegetation components is the main issue in this conversion process. While timber trees grow, coffee biomass is not affected and shade tree biomass can be reduced. Also monocotyledonous and dicotyledonous biomass is being replaced by fine litter biomass while timber trees grow. The different variables were significantly influenced by timber tree age, altitude and exposition.

Keywords: Agroforestry, Chiapas, Coffee, Conversion, Mexico, Timber

Production Efficiency under Different Agroforestry Practices in Ondo State, Nigeria

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The study examined production efficiency of some agroforestry practices, which is gradually replacing the traditional farming in Nigeria. This development is in order to conserve land resources and improve productivity. Given that productivity is a function of efficiency of resource use, this study examines the efficiency of different agroforestry practices in Ondo state of Nigeria.

A multistage sampling technique was adopted in selecting the farmers used in this study. In the first stage of sampling, five local government areas (LGAs) were selected from the existing eighteen LGAs of the State. In the second stage, 10 villages, were randomly selected each from the 5 LGAs. In the third stage, twenty-five agroforestry farmers were randomly selected from each village based on the list of agroforestry farmers in the areas. This gives a sample size of two hundred and fifty (250) respondents.

A structured questionnaire was the instrument used in collecting the relevant information from the respondents i.e. primary data were used in the study. The tools used for analysis to meet the objective of the study include the Data Envelopment Analysis (DEA), the Analysis of Variance (ANOVA) with a further t-test to test for efficiency differences among different practices.

The results showed that 10.3% of the farmers operated at full efficiency. This implies that about 89.7% were inefficient. The average technical efficiency was 44.7% for the whole sample. For the different agroforestry systems analysed, the average technical efficiencies were 41% (homestead), 52% (agrosilvicultural) and 73% (agrosilvapastoral) respectively. The input slacks further revealed that only land is a serious constraint while other resources are over-used. This implies that such resources can be reduced without necessarily affecting the level of output. The ANOVA results revealed significant differences in average technical efficiency between homestead and agrosilvicultural practices. Recommendations arising from the results of the study include extension-education awareness campaigns among farmers.

Keywords: Agroforestry, Data Envelopment Analysis (DEA), efficiency, Nigeria

Dynamics and Diversity of Undergrowth Vegetation in Lychee Orchards in Northern Thailand: Considerations for Sustainable Land Use

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In slopy hillsides, lychee (*Litchi chinensis*) is a typical fruit tree of the mountainous regions of northern Thailand. There, lychee production is subject to limitations by abiotic and biotic factors, which are mainly soil erosion, soil fertility depletion, weed pressure (grass-dominated herbicide flora) and pest/pesticide problems. Considering the constraints of sustainable agricultural production, the soil covering vegetation holds a key position in the agro-ecosystem. Adopting sustainable weed structure management strategies will favour synergies between individual measures including diversification of attending understory vegetation, soil conservation and pest control. It is well documented that wild plants play an important role by harbouring and supporting a complex of beneficial arthropods. Besides, the enhancement of plant biodiversity would contribute to the replacement of the current grass-dominated herbicide flora and creates a more suitable environment for beneficial arthropods which will help to suppress populations of lychee pests.

The present study deals with the effects of different mowing strategies of the natural ground vegetation on cover, structure and species diversity. In a lychee orchard, four different combinations of two pesticide (with vs. without) and mowing (monthly vs. once per year) treatments were conducted over a period of two and a half years. Effects of the four treatments on plant species numbers and abundances were recorded using vegetation quadrates. Diversity indices were calculated and multivariate statistical methods were applied to show differences between treatments. A total number of 170 species was recorded from the lychee orchard studied. Temporal species-specific reactions of selected species on the four treatments are documented. It was shown that mowing caused a shift in species composition. Generalisations referring to phenology or habit cannot be extracted, since each species reacted very specific regardless of the affiliation to certain phenology or habit groups. Seasonal and species-specific flowering of the species was documented in addition, because flowers provide important food resources for beneficial insects. The data provide information which are also of relevance for management approaches in order to restore degraded grassland areas.

Keywords: Diversity, lychee, management, sustainable land use, vegetation

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Fruit Trees in Coffee Agroforestry Systems in Costa Rica

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Following the worldwide coffee price crisis and its impacts on the economy of coffee exporting countries, such as in Central America, specialty and niche marketing possibilities were explored. Organic, bird-friendly, fair—trade or gourmet coffees are seen as a chance for farmers to achieve higher prices for their products in Costa Rica. Furthermore, many producers in Latin America tried to diversify their farms and products to decrease economical dependence on one cash crop. As shade canopy is now propagated for coffee plantations to increase sustainability of production and quality. Trees have been widely (re-)established, thus creating agroforestry systems.

In January and February 2005, interviews with 30 organic coffee producers in 12 communities of Turrialba, Costa Rica, were conducted. Apart from the characterisation (species, amount, production) of the trees present in the coffee field, the survey's objectives were to identify factors limiting fruit production and commercialisation (economical, infrastructural or ecological), the farmers incentive for establishing fruit trees into their production system, and the perceived impact of those fruit trees on the coffee.

Fruit trees provide additional household income and food but also require higher inputs in terms of workload, fertilisers and pest and disease management. Also, most coffee farmers have little experience working with fruit trees. Infrastructures for market access such as cooperatives are inadequate and information about requirements for larger-scale commercialisation and processing is rare.

The farmers who have participated in the survey have a highly diverse production of fruits in their coffee agroforestry systems, but higher quantities are produced of only a few products with a secure market (bananas, citrus, plantain, and guava). The other fruits serve mainly for household consumption or are lost. These two factors are also the main incentive for planting new trees, regardless of their impact on the coffee production. The diversification of the finca is generally seen as an economical benefit (higher income and security), though ecological effects are also perceived. Following this reasoning, finding accessible markets for less common products may be crucial for sustaining and promoting higher diverse production systems.

Keywords: Coffee agroforestry, Costa Rica, fruit trees

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Biodiversity Conservation in Agroforestry Land-Use Systems: Combining Environmental and Development Goals

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Establishing protected areas often generates high opportunity costs for the people living in these areas and, thus, leads to conflicts that impede the successful conservation of biological diversity. The integration of conservation aspects and poverty alleviation seems a promising strategy to reach environmental and development aims at the same time. Here, sustainable management of private-owned land becomes more and more important because of its potential to provide a variety of ecological goods and services for society. However, without payments for these services environmentally friendly land use often remains economically unattractive. Financial incentives might serve as a tool to achieve sustainable land-use management.

Our study focused on an economic comparison of different land-use systems. A cost-benefit analysis of coffee, rice, maize, and pasture land use was conducted and farmers' land allocation problems were studied in detail considering that net revenues and risks are major determinants for land-use decisions. Risk analysis techniques included Monte Carlo simulations and Stochastic Dominance. In this framework, we calculated opportunity costs of different land-use systems and analyse the impact of payments for environmental services in order to find minimum compensation payments for achieving pre-defined biodiversity targets. In case of legal conservation measures, such as the establishment of bio-corridors, opportunity costs of land-use restrictions can be compared.

When determining compensation payments that provide an incentive to maintain coffee production in biodiversity-rich systems, we found that the amount to be paid depends substantially on the production and income risk related to the respective land uses and on the 'portfolio' of different land uses a farmer holds.

The production of certified organic coffee in biodiversity-rich agroforestry systems is a promising way to improve the situation of small farmers in the region because (i) organised growers can achieve a more powerful position on the product market, (ii) the direct distribution channel avoids the participation of trading middlemen, and (iii) organic products have a higher price on international markets. This price could contain a 'biodiversity premium', and thereby finance the compensation payments required for maintaining biodiversity-rich land-use systems.

Keywords: Agroforestry land use, bio-corridors, biodiversity conservation, certified organic coffee

Morphogenetic Biodiversity and Local Use of the Himalayan Pear *Pyrus pashia* in Central Bhutan

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Little is known about the morpho-genetic diversity and use of the Himalayan pear (*Pyrus pashia*) cultivars grown in home gardens of smallholder farmers in Bhutan. Outside of Bhutan *P. pashia* is found in the Chinese provinces of Guizhou, Sichuan and Yunnan, in India, Kashmir, Laos, Myanmar, Nepal, W Pakistan, Sikkim, Thailand and Viet Nam. To study the biodiversity of *P. pashia* in Bhutan, a survey of 170 trees in two valleys of Bumthang in Central Bhutan was conducted in late autumn 2004. Its aim was the identification and description of the pear trees native to Bumthang following morphological traits such as colour, size and shape of fruits and leaves and the growth type of the trees. The survey also comprised farmers' knowledge of the use and origin of their trees and a semi-quantitative assessment of fruit quality and yield to discuss possibilities for income generation for the farmers, if proper marketing channels could be identified. Fruit samples of 170 trees were analysed for shape, size, colour, texture, taste and BRIX values (sugar content in percent by weight concentration of total soluble solids). The informal survey and semi-structured interview conducted in the two neighbouring valleys Tang and Chokhor of Bumthang revealed a high morphological diversity in *P. pashia*. The fruit shape varies from globose to pyriform, the fruit skin colour from light yellow and glossy to brown and dull. BRIX values range from 7.3 % to 15.5 %. The variation of yields over three years (2002 to 2004) ranges from 5 kg per tree and year to 1000 kg. The position of all trees was mapped with a hand-held GPS to include altitude as an integrating proxy for agro-ecological site conditions. The data were used to develop a simple classification key, which allowed a proper grouping of trees. Future work should include molecular approaches to verify the classification scheme and finally lead to an effective strategy to maintain the genetic diversity of the Himalayan pear at the farm level.

Keywords: Bhutan, Morphological diversity, *Pyrus pashia*

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Identification of Botanical Species of Oil Crops in the Region of West Pará, Brazil as Sources for Biodiesel Production

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The region of western Pará State in Brazil shelter a large number of neglected oil crops, many of them used locally as food additives or for medical purposes. Thus, these oils are of little economic importance. Therefore one objective of this and other research works is the evaluation of oil crops as energetic resource for biodiesel production. This research being part of the Brazilian government research programme for alternative renewable energy resources for biodiesel production. The following research is done primarily by field research in the middle Amazon Region at geographical locations near the intersection and along the Amazon and Tapajós Rivers. As main oil crops are targeted Arecaceae (Palmae) and Lecythidaceae species, amongst other cultures well known locally for their edible oil in the seeds and fruit pulp. Local area surveys yielded preliminary results identifying some species with high potential for vegetable oil production: Pajurá (*Pouteria speciosa* (Ducke) Baehni), Tucumã (*Astrocaryum aculeatum* G. Mey.), Andiroba (*Carapa guianensis* Aubl.), Umari or Mari (*Poraqueiba sericea* Tul.), Patauá (*Oenocarpus bataua* Mart.), Bacaba (*Oenocarpus bataua*), Piquia (*Caryocar villosum* (Aubl.) Pers.), Inajá (unknown species), Brazil-nut (*Bertolletia excelsa* Humb. & Bonpl.), Sapucaia (*Lecythis usitata* Miers), Babaçu-palm (*Attalea speciosa* Mart. ex Spreng.). These cultures show high oil contents in seed and/or pulp of up to 25,6 % in Piquia, up to 47,2 % in Tucuma, up to 12,8 % in Patauá, around 60 % in the nut of *B. excelsa*, around 45 % oil in the nut and 3,7 % of essential oil in the peduncle of the Sapucaia, and around 22,2 % in the Babaçu seeds. The preliminary results showed a high potential for oil crops in the central Amazon Region to supply the production chain of biodiesel with enough raw material in form of raw vegetable oil for the trans-etherification processes. Since most of the oil of some crop is found in the fruit pulp, it is, further, pretended to develop new extraction methods in order to get satisfactory results in the oil extraction.

Keywords: Biodiesel, extraction methods, lower Amazon, oil crops, Santarém, Tapajós River

Evolution of Sustainable Upland Agroforestry Systems — Case Studies from the Philippines and Viet Nam

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Productive and sustainable use of sloping uplands is the major challenge currently facing developing country agriculture. Development of agroforestry and farm forestry systems which control erosion has been difficult to achieve because of biophysical and socio-economic constraints. This contribution reviews approaches used in Mt Kitinglad Range Natural Park, Mindanao, Philippines and Tam Dao National Park, Viet Nam, working with disadvantaged groups. The development of farm models with erosion control contour banks planted with a variety of trees, food and fodder crops, and their extension to other farmers is outlined. The introduction of improved germplasm is an important component in developing farmer commitment. Women's livelihood improvement was addressed at the same time, with plant nursery development, clean vegetable production, tree planting, training and information centres as some of the components. Improved supply chain systems for farm products were developed at the same time. The importance of an integrated approach combining participatory approaches on-farm with local government agency involvement and networking with National Research Agencies is stressed. New extension approaches based on train-of-trainers down to the village extension worker along with provision of key inputs for new farming systems are in process of development in Viet Nam. Development of integrated and sustainable management of natural resources requires careful planning, the flexibility of action research, and commitment to a realistic time frame.

Keywords: Buffer zone management, upland agroforestry systems, farm models, erosion control, women's livelihood, natural resource management

Forests, Trees and NTFP

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Important Determinants of the Forest Land Allocation Process to Households in Northern Viet Nam

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Over a period of time, the Viet Nam government has enacted several policies and laws that have had a fundamental impact on the use of agricultural and forest land. Those that have had the most significant impact on the forestry sector have been the 1993-Land Law and Decree 02/CP, enforced in 1994. These introduced a hybrid forest management system between the state and households and transferred the use rights of the forest lands to households. The system was founded on the assumption that involving households in forestry activities and granting them benefits, would encourage these households to protect and develop the forests better. It has been ten years since the forest land allocation (FLA) policy was initiated. A number of problems have been encountered during its implementation process. The objectives of this research were to assess the FLA process to households and its determining factors, and appraise the effect of FLA on forest land use.

The analytical tools comprise multiple linear regression and logit models. The empirical data, comprising 139 households was collected. The main results show that the important factors determining a households' decision to apply for forest land included the total land available to a household, household income, the farmers' ethnic affiliation and a farmers' favourable perception of FLA. The total forest land allocated was significantly and positively influenced by the total farm land available to the household, the farmers' ethnic affiliation, the households' length of residence in the area, and the amount of support from forestry programmes to improve the forests. Forest land use after FLA has been influenced strongly by both, the FLA process and the socio-economic factors characterising households such as property rights, the size of forest land allocated to the household, the household head's standard of education, the distance to the market, and the income from the forests.

The study recommends that information on FLA policies should be widely disseminated. The government should assist the ethnic minority groups to invest in forests after FLA. It should also enable them to market their forestry products and provide infrastructure to improve the transportation links to the markets.

Keywords: Allocation, forest land, household, land use

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An Analysis of the Forest Utilisation Effects on the Structural Diversity in “El Cielo” Cloud Forest, Tamaulipas, Mexico

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Structural diversity is believed to be a good indicator of biodiversity. It has become apparent in recent years that forest management actions for timber production have undesirable consequences on the main components of forest stand structure: mixture, positioning, and differentiation. This study was intentionally carried out to analyse the forest utilisation effects on the structural diversity in “El Cielo” cloud forest, Tamaulipas, Mexico. The purpose was to gain deeper insight how the forest utilisation modified the species composition, the spatial structure and the dimensional structure in this type of forest ecosystem. Data from two experimental plots with different histories of management were used to assess the stand structure by using several indices. These indices are derived from the neighbourhood relations between the trees that constitute an ecosystem. The basis for the calculation of these indices was the sampling method so-called here “structural group of five trees”. By using this sampling approach, the spatial characteristics can be established merely on the basis of evaluating the immediate neighbourhood of a given number of reference trees. The results indicated that the plant community covering an area of half hectare was a mixture of tropical and template trees of approximately 30 different species with a density larger than 1000 trees per hectare. The neighbourhood parameters showed good tendency for detecting subtle structure changes; moreover, they are easy to calculate and interpret. The comparative structural analysis indicated significant evidences that the forest utilisation decreased the species diversity, modified the spatial distribution and changed the dimensional differentiation.

Keywords: Dimensional differentiation, diversity of species, spatial structure

Auxin Effects on Rooting of Stem Cuttings of *Grewia tenax*: A Potential Alleviator of Iron-Deficiency Anaemia in the Sudan

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The small-leaved white cross-berry (*Grewia tenax* (FORSK.) FIORI.) is a deciduous, tropical shrub or tree prized for its fruit. Being high in iron content, the fruit is considered as a simple safeguard against iron-deficiency anaemia. In spite of this, the fruit is exploited from the wild and there have been little or no focused efforts to domesticate and cultivate this species.

G. tenax is traditionally grown from seeds and information on the vegetative propagation is currently unavailable. The main disadvantage of seedlings is the genetic variability within the crop, which may result in variations in plant height, yield and fruit characteristics. On the other hand, vegetative propagation plays a key role in tree domestication and improvement programs as a means of a large-scale multiplication of superior genotypes. The retention of desirable characteristics, the creation of a uniform rootstock, and the ability to mass-produce identical plants quickly and efficiently are all advantages of asexual propagation.

A series of nursery experiments were conducted to assess the effects of auxin source [Indole Acetic Acid (IAA), indole-3-butyric acid (IBA) and α -naphthaleneacetic acid (NAA)], concentration (0, 1000, 1500 and 2000 ppm), duration of exposure (quick dip, one-minute dip and five-minutes dip) and form (liquid versus powder) on adventitious root formation in stem cuttings. Significant stimulation of rooting was observed with IBA at all concentrations and with IAA at 1000 and 1500 ppm. NAA at all concentrations was ineffective in promoting root formation. Maximum rooting success with IBA was achieved at 1500 ppm (43 %) and with IAA at 1000 ppm (37 %). Short-term exposure (as a quick dip or as a one-minute dip) of the cut surface to 1500 ppm IBA solution resulted in greater rooting success (57%-61 %) than a five-minutes dip (32 %). IBA in talcum powder worked slightly better than in liquid form (56 % versus 52 %).

Keywords: Auxins, *Grewia tenax*, rooting percentage, vegetative propagation

On the Contribution of NTFP Commercialisation to Rural Livelihood — A Case Study from Luang Namtha Province, Laos

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The utilisation and the management of NTFPs (Non-Timber Forest Products) as a ‘safety net’ or a ‘poverty trap’ are widely debated. Since recently, NTFPs and their contribution to people’s livelihood has been given increasing attention in Northern Laos. Among the large number of NTFPs used by local villagers only a few are commercialised. Locally traded products, like bitter bamboo shoots, bamboo canes, mushrooms, and vegetables, play a sub-ordinate part in cash generation and the barter economy of the producers, only. In contrast, middlemen and big export firms control the commercialisation of export products. Some of these are sugar palm fruit, ‘peuak meuak’, cardamom, and various bamboo worms.

Primary data sets had been collected in nine villages of the Luang Namta province. The availability of NTFP bearing forest resources and the distance to the market have been identified as the most essential variables affecting commercialisation. The forests, which surround villages nearby the bigger market places, lack NTFPs for export. People in remote settlements assess these NTFPs as an important source of cash income. Underlying reasons are the diminishing forest resources and the increasing orientation on cash crop cultivation in the villages near to the market. Remote areas are still endowed with rich natural forests and local people dedicate much of their labour to NTFP collection. Alternative sources of income are missing.

Poor collection and storage practices, the failure of a quota system and so, declining occurrence of valuable NTFPs in the forests, low-level value adding at the local scale and an in-transparent marketing system have been identified as major constraints on sustainable NTFP management. Derived from that, training, demonstration and pilot projects are recommended to assess potentialities of NTFP management in the natural forests, to further production of value added in the villages and small towns of the region, and to find out possibilities for the domestication of the respective plant species following participatory approaches.

Keywords: Commercialisation, NTFP, rural development, value adding

Protection of Timber Resources by the Introduction of Income Generating Measures - An Approach in Ghana

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The project area is located in the Ashanti Region in Ghana / West Africa. The Ghanaian wood processing company Dupaul Wood Treatment is establishing forest plantations in the transition zone of forest and savannah areas in the northern parts of the Ashanti Region. Since a fire blast in 1983 destroyed the forest and the high income benefiting cocoa plantations in the area, the main land use system changed to “slash and burn” agriculture. Food crops like Yam, Cassava, and Maize are the main products. Fire outbreaks, caused by the „slash and burn“ technique and the hunting of bush meat, destroyed parts of the forest plantations in the last years. To minimise the risk of fire outbreak in the forest plantations and to increase the income of the rural population in the project area, Dupaul Wood Treatment supports farmers in the establishment of farms with perennial crops and further income generating measures. These activities include the establishment of orange, mango, oilpalm or cashew farms using improved varieties and the support of farmers in establishing forest stands using agroforestry techniques for the production of fuelwood, poles and saw timber. The farms are partly organised as a “belt” around the forest plantations, other farms are scattered in the surrounding area. The farmers gain a higher income compared to the “slash and burn” technique and, furthermore, develop their own interest in avoiding the occurrence of bush fires in the area. The introduction of grasscutter rearing is a further income generating measure which shall lead to a decrease of fire outbreaks in the area. The meat of grasscutter (*Thryonomis swinderianus*) is a delicacy in West Africa and fire is frequently used for the hunting of the animals. The domestication of grasscutters shall partly replace the hunting of wild animals and, therefore, reduce the risk of fire outbreaks. This project could develop as a model for a close cooperation of a private afforestation project and its neighbouring farmers, benefiting in substantial gains for all parties involved.

Keywords: Agroforestry, bushfire, forest plantation, Ghana, grasscutter rearing, income generating measures

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Agriculture and Biodiversity in Fragmented Landscapes of the Atlantic Rainforest of Rio de Janeiro

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Crop and animal husbandry systems were evaluated in the Atlantic Rainforest (Mata Atlantica), located in the hinterland of Rio de Janeiro, Brazil using the municipality of Teresópolis as study area. Their influence upon the conservation of biodiversity, agro-diversity, landscape and society was appreciated.

Landscape evolution over time was analysed with the help of GIS. Farming systems were characterised and classified by way of three different surveys implemented on a total sample of 304 agricultural production units. Thereafter, 18 well contrasted farms were chosen and studied during one year with the purpose of knowing economic productivity, dynamics of biomass, market relationships and finally, agro-diversity.

The specific study was carried out in the “Corrego Sujo” basin with a surface of 51 km² divided in 9 sub-basins, located at an average altitude of 900 m asl. In the latter basin, 36 % of the surface was identified as fragmented forests —12 ha on average— and undergoing severe pressure from agricultural expansion and fire. Although horticulture occupies only 3 % of the area, it impacts negatively on soil and water due to inappropriate use of irrigation and agro-chemicals. The low productivity grassland corresponds to 31 % of the area and isolates the fragments, impeding consequently on natural dispersion of seeds and on animal movement. The remaining 19 % of the area corresponds to regeneration sites that are likely to revert to grassland.

The economic and ecological viability of the different agricultural systems was evaluated, including agroforestry, silvo-pastoral systems, forestry, other perennial crops and vegetable growing. Above systems were appraised as to their pressure on deforested areas and fragments, as well as to their additional benefits to local population, encompassing influences on micro-climate, water cycle, nutrient flow, dissemination of pests and diseases, and on dispersion of fauna and flora.

Above mentioned agricultural systems were rated for their protection of resources, habitat, plant and animal survival. Unconventional agricultural systems may play an important role in linking and buffering fragment reserves and in contributing to the improvement of both agro-diversity and biodiversity in these degraded areas of the Atlantic rainforest.

Keywords: Agro-diversity, atlantic forest, biodiversity, farming systems

The Potential Carbon Sequestration Secondary Forests and Agricultural Land Covers in the Landscape of Eastern Amazonia, Brazil

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The Bragantina region in the eastern of Amazonian region was former covered by moist tropical forest. During the last century, the area was transformed to an agricultural landscape with highly exploited remnants of the original forest restricted to flooded areas. Secondary forest regenerates mainly by re-sprouting from trunks and roots after a cropping period 1 to 2 years. The intensification of land use with mechanized land preparation and short fallow periods implies a progressive degradation of soil that affects the vitality of secondary forests and crop yields. Management of forest fallows among others activities represents an option to conserve the forest, to ensure nutrient storage and to increase the sequestration of atmospheric carbon.

This research assessed the potential of secondary forest and some land covers to accumulate atmospheric carbon. A significant linear equation with a R^2 of 0.92 represented the aboveground biomass of the carbon pools: live trees, litter and dead trees in relation to average height of highest canopy stratum. The carbon accumulation overpass 100 t C ha^{-1} when trees in the canopy reach 20 m. The potentialities of carbon uptake of different common land covers in the study area were calculated combining field data with Ikonos images and extrapolated to the Municipality of Igarapé Açu and Bragantina region using estimation area from agricultural census. The current extension and distribution of the secondary vegetation in the region only recovered the 5 % of C released by replacement of the original forest.

Keywords: Amazonia, biomass, carbon sequestration, fallow vegetation, secondary forest

Contribution of Non-Timber Forest Products to Poverty Alleviation in Benin: Opportunities, Challenges and Strategies

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It is widely demonstrated and recognised today that Non-Timber Forest Products (NTFP) play a major role in the food security and the subsistence strategies of the rural populations everywhere in the world and thus can be integrated into the struggle against poverty.

A national survey conducted in different localities of the country and an inventory of the diversity has revealed 190 species collected and used as food either for their fruits, seeds, roots, tubers, leaves, saps and flowers. Many of these species have also some medicinal uses. Others are processed, and traded providing some important revenues to the population and thus given to them an important economic value. These important species are not collected only in the wild but are for some of them present in the home garden and the traditional agroforestry system.

Based on a set of criteria like the socio-economic and cultural importance, the indigenous knowledge, the presence in the home garden and/or agroforestry system, the existence of traditional processing methods, the existence of national, regional and international market; some 15 keys species have been identified for promotion. The important species in the Northern part of the country (between 8° and 12° N) are *Adansonia digitata*, *Vitex doniana*, *Bombax costatum*, *Blighia sapida*, *Borassus aethiopicum*, *Vitellaria paradoxa*, *Parkia africana*, and *Tamarindus indica*. In the Southern part (between 6°30' N and 8° N), the most important species are *Vitex doniana*, *Dialium guineense*, *Chrysophyllum albidum*, *Uvaria chamae*, *Annona senegalensis*, *Irvingia gabonensis*, *Cyperus esculenta*, and *Corchorus tridens*.

This paper will present those species but also the issues, the challenges and the strategies to their development and how they can contribute to reduce poverty in Benin. The actions to be taken by the different stakeholders for the promotion of these key species will be discussed.

Keywords: Agroforestry, Benin, NTFP, poverty alleviation, socio-economy

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Detection of Shifting Cultivation Using Satellite Based Change Detection Techniques in the Nam Ton Watershed, Lao PDR

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When looking for critical areas in the context of erosion and degradation in Lao PDR, the regions that are affected by shifting cultivation are prior and most distinct visual. Up to now these areas have not been assessed and their distribution is rarely described in literature. This makes it unclear whether this practice has a cause in the further depletion of the natural forest resources in Laos. The objective of this study was to test a methodology that can detect patterns of shifting cultivation and forest clearing inside the major watersheds of Laos. In order to find an optimal change detection technique, different Landsat image-to-image comparisons were used for detecting major landcover-changes over a three year period (1997, 2000, 2002). An unsupervised classification after a tasselled cap transformation had the best overall accuracy of 84.5%. Unsupervised classification after principal components analysis or vegetation indexing had overall accuracies which were respectively 81.9% and 71.4%. In general, the image-to image comparison technique showed a clear distinction between patterns related to shifting cultivation and changes which have different causes. It is concluded that the processing of the satellite remote sensing data is a very useful application in the monitoring of the shifting cultivation in Laos.

Keywords: Principal components analysis, shifting cultivation, tasselled cap transformation, vegetation indexing

Surveying and Collecting Native *Centrosema*, *Stylosanthes*, and *Desmodium* Germplasm in Venezuela

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Venezuela is considered as one of the countries with the greatest biodiversity in the world. Such attribute is explained by the variety of topographic, climatic and edaphic conditions. Consequently, the country comprises a large number of different natural environments such as high mountains, arid and semiarid regions, tropical forests, wetlands and savannahs, and 22 different life zones and more than 600 vegetation types have been identified. As a result, the existing flora is very rich, with a high diversity of native legumes. Exploration and surveying of Venezuelan native legumes, specifically *Centrosema*, *Stylosanthes*, and *Desmodium*, were carried out between 2000 and 2002 as a collaborative project among several national institutions. Fifteen intensive exploration and collecting trips of varying duration were carried out during the dry months of that period. These missions covered eight states in areas such as the central and eastern llanos, and the foothills and mountain zones south of the "Cordillera de la Costa". A total of 152 seed samples, 79 herbarium specimens, 50 soil samples and three of root nodules were collected. The germplasm included eight, seven and five identified species of *Centrosema*, *Stylosanthes*, and *Desmodium*, respectively. The former genus was the most collected, with a total of 91 seed samples representing 60 % of the total collection, followed by *Stylosanthes* with 33 samples (22 %), and *Desmodium* with 26 (17 %). Within each genus, the most collected species were *C. molle*, *S. hamata* and *D. tortuosum*, with 46, 6 and 5 samples, respectively. Maps with the geographical distribution of the entire collection, as well as a preliminary classification of a 34-accession collection of *C. molle* by climatic groups, using the GIS software FLORAMAP™, are presented. The resulting groups within the *C. molle* collection are based on differences in total rainfall and its annual distribution, as well as the altitude and temperature of the collecting sites. Possible associations between natural distribution, climate, soil texture and fertility, and habitat of origin are discussed. The actual germplasm collection has been the basement for the creation of the national seed-bank of forage plants.

Keywords: *Centrosema*, *Stylosanthes*, *Desmodium*, legume collection, natural distribution, plant genetic resources (PGR)

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Species Diversity of the Tropical Legume Genus *Stylosanthes* in Venezuela

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Stylosanthes is a predominantly neotropical genus with several species currently used as forage, for soil cover and improvement, and increasingly for leaf meal production. Some species are well adapted to prolonged drought conditions and to the acid, low-fertility soils that prevail in the tropics. This makes *Stylosanthes* particularly important for cultivar development for low-input production systems.

Venezuela can be considered, after Brazil and Mexico, as the third centre of diversification of *Stylosanthes*. The most important Venezuelan contribution to cultivar development of a tropical forage species is *S. hamata* cv. Verano, an ecotype that was opportunistically collected in the mid 70s in Maracaibo and which is currently the world's most important pasture and ley-farming legume for the dry tropics. *Stylosanthes* species have a wide natural distribution in Venezuela and are found in a broad range of environments. According to taxonomic studies, eleven species occur in the country: *S. angustifolia*, *S. capitata*, *S. gracilis*, *S. guianensis*, *S. hamata*, *S. humilis*, *S. scabra*, *S. sericeiceps*, *S. viscosa*, as well as two new, as yet undescribed species.

To properly assess and subsequently utilise the potential of both inter- and intraspecific diversity of *Stylosanthes* for cultivar development, and to create the basis for future collection strategies, a database of Venezuelan *Stylosanthes* material was assembled: approx. 1.000 specimens held in indexed Venezuelan herbaria and five major US herbaria were documented, and passport information of approx. 500 Venezuelan *Stylosanthes* germplasm accessions held at major gene-banks recorded, constructing a comprehensive biogeographical database. Using FloraMap™, a GIS tool combining topographic and climatic information, maps of both actual and predicted distributions of each species were generated.

As a result, we could identify not only species niches, plant populations and geographic regions with importance as a source of germplasm, but also collection gaps. The information assembled will furthermore help to better understand species distributions and adaptations, and to design further collection and conservation strategies. In addition, we found FloraMap™ to be a powerful tool for mapping geographic distributions, but to improve prediction accuracy, it needs to be complemented by other GIS tools which also take soil characteristics into account.

Keywords: Biogeography, cultivars, FloraMap™, legumes, *Stylosanthes*, Venezuela

Evaluation of Physical Land Suitability for the “Thanh Tra” Pomelo Crop in Hue, Viet Nam

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“Thanh Tra” pomelo (*Citrus grandis* L. Osbeck) is one of the major fruit crops in Hue, Central Viet Nam. Its commercial production is an important source of income for many farmers. The production of “Thanh Tra” pomelo is being rapidly developed both in terms of quality and quantity. However, productivity and production of “Thanh Tra” pomelo are low when compared to those in south and north of Viet Nam and other countries. There are some considerable constraints facing “Thanh Tra” pomelo development, including socio-economic factors and physical conditions. Evaluation of physical land suitability for “Thanh Tra” pomelo is a prerequisite for sustainable agricultural production and it involves of the multi-criteria evaluation.

This study aims to determine physical land suitability areas for the “Thanh Tra” pomelo production and sustainable agriculture development of a representative village Thuy Bang, Hue, Viet Nam.

The methodology used for the physical land suitability analysis for “Thanh Tra” pomelo is a multi-criteria evaluation approach within GIS context, based on FAO land evaluation framework (1976, 1983), modified for Vietnamese conditions. The methodology consists in matching soil/land qualities against ecological requirements of “Thanh Tra” pomelo.

Thuy Bang was selected as a representative village for this study, with an area of 2298 hectares with 16 soil units (FAO/UNESCO/WRB). Slope varies from 3°-25°, soil depth is 30 cm to more than 100 cm, water resources are scarce, and soil fertility is poor to moderate. The study was carried out by overlapping all individual maps (soil map, soil depth map, slope map, texture soil map, and soil fertility map) with GIS techniques for land evaluation mapping of units and for physical land suitability classification. Results showed that there are 32 land evaluation mapping units in the study village. A total of 1322 ha were suitable for “Thanh Tra” pomelo production, of which 10 % was moderately suitable (S2), 90 % was marginally suitable (S3). Lack of irrigation, erratic rainfall and poor soil fertility are the two most serious problems influencing yield and quality of “Thanh Tra” pomelo.

Keywords: Evaluation, GIS, land evaluation units, physical land suitability, “Thanh Tra” pomelo

Regionalisation of Wind Erosion Potential in Sahelian SW-Niger

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The sub-saharan Sahel is one of the biggest areas in the world affected by increasing desertification, caused mainly by water runoff in the wet season and especially by processes of wind erosion. The quantification of wind erosion potentials of Sahelian surfaces was up to now carried out mainly in the framework of field experiments during naturally occurring dust storms or as long-term experiments. The comparability of the respectively gained data is difficult due to non-reproducible conditions during the specific storm events. Erosion potentials of different surfaces can nevertheless be compared by establishing standardised and reproducible, quasi-natural wind and flow conditions, thus minimising the variations of meteorological conditions. During the field experiments conducted by the Klimex work group of the IBS, these standardised conditions were created by the means of a mobile wind tunnel. Surfaces of the most representative geomorphological units were chosen as study sites. External factors like anthropogenous disturbance of topsoil structures were incorporated in the measurement program. The measured variables comprise the emitted sediment as a function of height, wind profiles at different flow intensities and specific surface roughness. The respective (top)soils were additionally analysed in the laboratory in order to provide input data for the model and to determine the physico-chemical composition of the eroded sediment.

The next step was the regionalisation of the point-data with the help of classified Landsat satellite scenes and WEPS (Wind Erosion Prediction System) a wind erosion model, which was adapted to Sahelian conditions. First results of model runs / scenarios are presented.

Keywords: Modelling, regionalisation, Sahel, wind erosion, wind tunnel

Time Related Landscape Changes in Yutian Oasis at the Southern Fringe of Tarim Basin in NW China

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Little is known about time-related changes in the agricultural structure of ancient melt-water oases along the silk road in the hyper-arid Taklamakan desert of Northwest China. Recently released, high-resolution b/w aerial photographs taken in 1956 and an ETM+ satellite image taken in 2002 were used to compare such changes in Yutian oasis at the northern fringe of the Kunlun mountains, where melt-water is used to produce crops on irrigated farmland. Image analysis showed a complete transformation of the oasis' agricultural setting over the time period studied from an extensive agriculture system with a total cultivated surface of 17,970 ha, a canal length of 3,133 km and a higher landscape diversity compared to today's 21,300 ha oasis surface and a canal length of 4,068 km in 2002. Whereas the modern-day agriculture structure with its chest-board type system of cement-lined irrigation canals may fit the need of intensive agriculture based on commodity crops such as maize (*Zea mays* L.), cotton (*Gossypium hirsutum* L.) or melon (*Cucumis melo* L.), it likely consumes much more water than the traditional system. This may lead to the reduction of melt-water available for the foreland vegetation protecting the oasis from encroaching sand dunes of the surrounding desert.

Keywords: GIS, image analysis, oasis transformation, Taklamakan

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Modelling and Measuring the Economic Success of Farming Families Using Spatial Methodology: A Case from Mountains of Nepal

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Development of socio-economic condition in many mountainous areas of Asia is mostly influenced by their spatial position. Socio-economic differentiation across the spatial gradient is due to the differentiation of resource availabilities, management, availability and the condition of infrastructure. The co-existence between biophysical and socio-economic condition raised the question whether there is a relationship between these two sectors and which factors determine the future development. This paper presents the methodology to model the economic success of farming families and measures the impact of development strategies on economic success using spatial models.

Socio-economic conditions were assessed based on a survey with in-depth interviews with randomly sampled families. Biophysical and infrastructure data and satellite images were analysed in image processing and GIS. Road infrastructures were analysed using cost weighted distance model and land quality indexes were prepared. Socio-economic data were integrated in GIS by means of interpolation. GIS based regressions were constructed to establish the functional relation between economic and biophysical variables. Model results were compared with the survey results and based on the relation impact of assumed improving and worsening environment to the economic success were tested and presented.

The model shows that economic success of farming families (farm family income) can be estimated through the biophysical variables (cost distance to market, land quality indexes and land productivity). Improvement of land quality through soil conservation shows promising results in the currently low-income areas. Similarly, development and improvement of the road network, water management and combined strategies show their impact will be highest in the remote areas that are currently least accessible, low income. Water management strategy show an increment of annual income by 71–95 % to those of upland agricultural areas, which has currently no irrigation. Combined strategy of water management and road network shows an increment of income by 90–160 % for the low-income areas. Soil degradation scenario shows income loss would be higher around currently low-income areas in future, if the current situation continues. In conclusion, if the tested strategies will be implemented an improvement of economic conditions in the currently disadvantaged areas with low levels of natural resource endowment and economic success could be achieved.

Keywords: Farm family income, GIS, Nepal, spatial differentiation, spatial modelling

Citrus Inventory (2004) in Bella Vista, Corrientes — Argentina

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The domestic market is the primary target for citrus in Bella Vista, Corrientes, Argentina. Since 2001 economic changes took place and the export of fresh fruit began to the European market. A comprehensive inventory was developed at the request of the Citrus Growers Association in order to determine future investment strategies. In a first step, we assessed the citrus growing area regarding the geographical location of the plots, prevailing agronomic practices (species, varieties, agro-chemical use, age of plantations), and farmers' access to extension services. An initial inventory was based on Landsat 5 and Landsat 7 satellite images. Before the visual interpretation, the images were rectified and processed using ERDAS Imagine. ArcView software was used to develop the GIS and ground-truthing of the GIS information was complemented by questionnaires.

The results show that 23 % of the citrus plots are abandoned. Only some 380 plots are actively exploited, corresponding to a production surface of 3,021 ha. The average age of these plots is 11 years, indicating that the maximum production potential has not yet been reached. The largest share of 49 % of the area is occupied by lemon, followed by oranges (32 %) and tangerines (19 %). In the case of lemon, one single variety ("Villa Franca") is used on 46 % of the total lemon-growing area, while Valencia represented 84 % of the oranges. This high concentration on few varieties carries danger signals, as reliance on few genotypes is potentially associated with economic risks and a loss in agro-biodiversity. Despite their recognised importance, only 40 % of the citrus area is currently treated with agro-chemicals and extension reaches less than 30 % of all citrus growers. This inventory highlights that current citrus production levels in Bella Vista appear to be less associated with spatial features but rather with a lack of information by farmers and possibly an over-reliance on few genotypes. Further sociology studies are needed to explain the poor use and access of extension services.

Keywords: Agro-chemicals, extension, GIS, satellite images

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Characterisation of Soil Surfaces in the Arid and Semi-Arid Zone by Means of Remote Sensing

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In the framework of a study carried out on potential dust sources in arid and semi-arid regions in Chad, it was necessary to undertake a regionalisation according to the physical, geo-chemical, and mineralogical characterisation of soil surfaces in the area. Due to the fact that the sampling locations had been selected already on the basis of Landsat TM data, it was at hand to also use these satellite data for the regionalisation.

A first screening showed that some bands of Landsat TM (e.g. Band 3) are frequently in range of saturation. Therefore, it appears not to be reasonable to use Landsat data to correlate spectral reflectance with soil surface properties. Instead, first correlations between soil surface sample properties (texture, electric conductivity, free iron primary and clay minerals) from laboratory and Landsat hyper-spectral and spectral signature (IRIS radiometer) data measurement were established. Recorded IRIS data have been done with respect of natural surface.

This approach necessitates to form groups of correlation for further analysis. Soil surface types like Hamada (gravels), sandy, or lacustrine should be separated in the case that soil properties are identified on the basis of singles bands. However, it is not necessary to build groups for soil properties when bands are combined.

Considering the multiplicity of the influencing parameters, statistical analysis (factor analysis multiple and partial regression) was applied in order to identify the governing factors of the spectral properties.

The results of this approach will be presented here. As a result of this preliminary analysis, it was possible to establish high partial correlation between spectral reflectance of soil surface and specific soil properties. However, some problems appear with certain surfaces like Hamada due to their heterogeneity.

Keywords: Remote sensing, semi-arid zone

Integrated Farm-Scale Modelling of Land, Water and Resource Allocation in the Khorezm Region of Uzbekistan

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Irrigated agriculture in the Khorezm region, situated in the Aral Sea Basin of Uzbekistan, is characterised by excessive and unsustainable use of water, land and resources, such as fertiliser and pesticides. It is assumed that this is a consequence of the current post-Soviet economical and institutional framework conditions, for instance by the state-imposed production of cotton. In detail however, the picture is not clear. The resource use efficiency of the land use system as such still remains to be quantified and clearly described. There is also a basic need to seize the complex institutional, economic and agronomic interdependencies. Based on a thorough system understanding, recommendations have to be developed for an ecologically and economically improved resource use and for the institutional and legal setup needed to support it. As system dynamics are highly complex in nature, computer modelling provides the only viable option for tackling these issues.

As a first step to reach this goal, in the framework of the multidisciplinary, German-Uzbek research project “Economic and Ecological Restructuring of Land- and Water Use in the Khorezm Region (Uzbekistan)” — a pilot project in development research’ (www.uni-bonn.de/khorezm) — a farm-level scenario-analysis and optimisation tool is being developed. This integrated model will allow for the analysis and/or optimisation of the status quo and simulation of different scenarios of farm-level land and resource allocation. The model will integrate four different components: a crop-soil-simulation model, a hydrological model, a linear programming/optimisation tool and a GIS/database component for spatial analysis and to account for data storage and visualisation. The integration of these components will be realised within the so-called COBIDS (component-based integration of data and services) framework.

The poster describes the setup of the model and how the interactions between the components are accomplished. The usefulness of applying the Unified Modelling Language (UML) in the development process of the model is briefly discussed.

Keywords: Central Asia, crop-modelling, farm optimisation, interdisciplinary research, linear programming, sustainability

Crop Genetic Resources and their Management

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Out of Latin America: Medicinal Herbs Production, Trade and Consumption in Chile and Mexico

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Medical traditions from the New World have largely contributed to ameliorate European pharmacopoeia with native medicinal herbs, from the fifteenth century onwards. Medical knowledge evolution, based on chemicals, together with recent biology and genetic sciences discoveries, increasingly led by technological advances, tend to minimise that historical contribution. Still, new chronic diseases treatment and evolving healing conceptions are more likely to be less critical to the old ways, via alternative medicines, the same way patients seek for viable alter complements than pills to restore their well being. This search is particularly evident within Latin American populations currently under study by means of comparative ethno-geography and ethno-botany projects, aiming home gardens in Santiago, Chile and the Mexican capital city. Indian descendants are recognised for their faith on ancestral therapeutics, ranging from plant-therapy, animal secretions, and healing powers of medicine men and women. Culture, religion and old cosmological beliefs quest is thus quite imperative to fully explain local options in a global standardised world, where public health is organised and universal medical assistance sought. In order to further understand dynamics and conflicts in medicinal herb production, transportation and trade chains inside great metropolitan areas, the team has been sample researching central urban and gross peri-urban markets, whilst targeting vegetables with double purposes. That's the case with *Chenopodium ambrosioides* for instance, commonly named Paico in Chile and Epazote in Mexico. The herb has wide usage both as food and medicine, for its benefices as a digestive and proved anti-parasites effect. The work is part of a Portuguese Tropical Research Institute interdisciplinary search for ancestral healing and palliative traditions targeting Latin America, along with determined *in situ* preservation efforts backed by *ex situ* genetic reserves conservation, which includes live plant collections available for reintroduction into damaged habitats as well as future medical and pharmaceutical applications.

Keywords: Alternative healing practises, comparative studies, great metropolis, interdisciplinary tropical research, medicinal herbs, medicines dynamics and conflicts, plant conservation

Analysis of Farmers' Demand for Rice Varietal Attributes in the Terai Region of Nepal

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Much of the efforts of breeding programs in Nepal have been focused on generating varieties with high yield potential. It is now a well established fact that farmers' selection criteria for varieties to adopt encompasses many varietal attributes with some of them considered more important than yield potential.

The main objective of this paper is to assess the farmers' preference for varietal technology attributes and identify their determinants. Non-parametric tests were employed to test for the statistically significant differences between/among the farmers' categories with regard to ratings for an attribute. An ordered probit model was used to identify the determinants for major attributes.

Farmers' preference are driven by the need for production, tolerance to stress, consumption, marketing and management considerations. Farmers have rated many of the listed varietal attributes between very important and some how important. This suggested that farmers demand varietal diversity since it is unlikely that a single rice variety will be good at supplying all of the attributes they value. Hence, many subsistence farmers usually mix several varieties because of the impossibility to find all desired varietal attributes in one single variety.

There are important variation in the demand for attributes depending upon the economic status of the farmer, his/her farming objective, and the ownership of the land. A beneficial characteristics for one farmer may be a negative one for other, or the balance between positive and negative traits may be acceptable for the farmers. These facts need to be considered while developing new varieties in order to meet multiple requirements of different categories of farmers.

Keywords: Attributes, farmers, Nepal, preference, variety

Cassava Mosaic Disease Resistance in Transgenic Cassava

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Cassava (*Manihot esculenta*) is a staple food for 600 million people in the tropical and subtropical belt, as well as a feedstock for numerous industrial applications, including food, feed and starch. Cassava Mosaic Disease (CMD) is one of the major problems encountered in cassava fields in Africa where the disease can trigger overall yield losses up to 25 %. CMD is caused by whitefly-transmitted gemini-viruses. Synergism, recombination and pseudo-recombination between different cassava gemini-virus species have led to the recent pandemics of severe CMD in Africa. Our research aims at developing different CMD prevention strategies in transgenic cassava and therefore providing local farmers with gemini-virus resistant lines to secure cassava production.

Using antisense technology, the first cassava lines resistant to African Cassava Mosaic Virus (ACMV) have been produced in our lab and are about to be field-trialed in Africa. We are now trying to engineer broad-spectrum gemini-virus resistance in cassava. The new approach is based on down-regulation of viral protein production through the RNA interference (RNAi) pathway. RNA interference is a conserved silencing mechanism which accounts for mRNA regulation via post-transcriptional silencing (PTGS) and/or transcriptional gene silencing (TGS). The specificity of this RNA regulation is based on homologous short double-stranded interfering RNAs (siRNA). Transgenic cassava expressing hairpin double-stranded RNA (dsRNA) homologous to gemini-viral sequences are expected to reduce viral mRNA production leading to decreased levels of viral replication and movement in the infected plant. Highly conserved sequences amongst gemini-viruses species have been considered to be the best target candidates for a RNAi-based resistance.

We have successfully speeded up the recovery process in infected cassava plants by expressing hairpin dsRNA targeting the gemini-viral promoter region. *In vitro* and *in vivo* studies suggest that CMD resistance could be due to a reduced level of virus replication in transgenic cassava plants. We are currently combining different potential viral mRNA targets in order to optimise the RNAi strategy in cassava.

Keywords: Cassava virus resistance, RNAi

A Global Initiative to Conserve Crop Wild Relatives *in situ* through Enhanced Information Management

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The natural populations of many crop wild relatives are increasingly at risk and they are presently poorly conserved. A major limitation is in the capacity to manage and use information that does exist. Therefore a project was developed to address national and global needs to improve conservation of crop wild relatives, focusing on enhanced management and use of information on these species. It brings together five countries – Armenia, Bolivia, Madagascar, Sri Lanka and Uzbekistan – and five international conservation agencies – the Food and Agriculture Organisation of the United Nations (FAO), Botanic Gardens Conservation International (BGCI), the United Nations Environment Programme's World Conservation Monitoring Centre (UNEP-WCMC), the World Conservation Union (IUCN) and the German Information Centre Biological Diversity (IBV). The project is coordinated by the International Plant Genetic Resources Institute (IPGRI).

Up to now 64 crop genera comprising about 12,000 species have been identified as the focus of the project. The number is likely to increase with inclusion of a great number of crops listed in Annex 1 of the International Treaty on Plant Genetic Resources for Food and Agriculture.

The above mentioned national partners will implement and monitor conservation strategies that are needed to conserve priority crop wild relatives in their countries. They will undertake ecogeographic survey and analysis on three to five taxa and use this information to refine procedures for using spatial information as a tool in conservation management and monitoring.

The information portal will bring together information from available data sources on the identity, status, distribution and potential use of crop wild relatives. The five participating countries will provide information from their own systems as the projects develops and it is hoped that other countries will also provide their information in due course. The portal will act as a gateway for access for the global community allowing users to search for information on the global level but also allow for access information on the national level.

Keywords: Biodiversity, crop wild relatives, information management

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Plant Regeneration via Organogenesis and Embryogenesis in Sweet Corn

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Synthetic seed consisting of somatic embryos enclosed in protective coating are a suitable tool for clonal mass propagation of elite plant varieties. Sweet corn (*Zea mays* var. *saccharata*) embryogenic callus were derived from culturing immature zygotic embryos at 11 days after pollination on N6 medium that contained 2,4-D 2 mg l⁻¹ and sucrose 60 g l⁻¹. Somatic embryos developed when transferred embryogenic callus to N6 medium containing 2 mg l⁻¹ 2,4-D and 30 g l⁻¹ sucrose. Sweet corn synthetic seed was produced by somatic embryos encapsulated into a protective calcium-alginate matrix which provides mechanical support, protection and was coated with a wax film to prevent desiccation.

Synthetic seeds were produced. It was found that when synthetic seed were treated with 60 g l⁻¹ sucrose and stored at 15±2°C for 2 weeks, the percentage of germination of synthetic seeds were 42 %, with 91 % normal seedlings and 8 % abnormal seedlings after they germinated for 8–9 days. When the synthetic seeds were dehydrated by silica gel until 60 % moisture content and then stored for 2 weeks, they could germinate at a rate of 23 %, with 83 % normal seedlings and 17 % abnormal seedlings.

During storage, it was also found that microorganism contamination could be controlled by benomyl. The survival ratio in sweet corn synthetic seed in this investigation indicated that there is still some more research required to increase the number of the survival seeds and the optimum storage technique to prolong their viability.

Keywords: Embryogenesis, organogenesis, plant regeneration, sweet corn, viability

Specific Isozyme Pattern of Rice Seed Cv. Kaodawkmali 105 and Cv. Chainat 1

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Genetic purity of rice seed is one of the factors for good quality rice seed production. Using mixed rice seeds has been practised recently by Thai seed farmers, since the mixed seeds used are bought from local traders. Mixed seeds from rice var. KDML 105 which is more expensive than var. CN 1 is most commonly practised. The use of mixed seeds is heavily increased because the traders are lowering the seed price and the morphological appearance of both mentioned varieties is almost the same. Therefore, the international rice trading agencies in Thailand have brought up this problem into public discussion. The purpose of this experiment was to find out a better and cheaper way than well-known expensive laboratory analysis techniques e.g. DNA fingerprint, to identify varieties. Such a simpler and quicker method could be a specific isozyme electrophoresis.

The determination of the specific isozyme patterns of rice seed cv. KDML 105 and CN1 was done by using the method of polyacrylamide gel electrophoresis technique (PAGE). Five enzymes; esterase (EST), glutamate oxaloacetate transaminase (GOT), leucine amino peptidase (LAP), malic enzyme (ME) and malate dehydrogenase (MDH) were assayed. It was found that the esterase enzyme shows distinguished differences for these two rice seeds cvs. No distinguished differences of the isozyme pattern in other enzymatic patterns were found.

Thus, esterase enzyme electrophoresis technique could be used to separate the rice seed mixture of var. KDML 105 and CN1. Further research is recommended.

Keywords: Polyacrylamide gel electrophoresis, rice seed, specific isozyme pattern, technique

Morphological Diversity of Lam Dong Tea, Viet Nam

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Assessing the diversity in tea (*Camellia sinensis*) may provide the basic information for tea plant breeding in order to build up set of regionally adapted tea populations and clones. All tea taxa freely interbreed and therefore tea plants, with many overlapping morphological, biochemical and physiological attributes, are highly diverse and consequently their populations are very heterogeneous. Because of the extreme hybridization, existence of the pure archetypes of tea is doubtful.

Thirty-one teas belonging to China tea, India tea, Shan tea and hybrid tea, which are either commonly planted commercially or promising in tea germplasm, were morphologically described at four locations in 2004 at Lam Dong province (Viet Nam) and assessed for the morphological diversity. Thirty-four morphology characteristics of stem (stem circumference and stem shape; the height of the first branching position; branch angle to stem and branching ability; the height, the length and the breadth of plucking surface), the 4th leaf (leaf length, leaf breadth and leaf size; leaf length/breadth ratio and leaf shape; leaf angle to branch; leaf pose; leaf colour; number of pair of main vein on leaf surface; number of pair of serrulation on leaf margin and serrulated form; the length from leaf pedicle to first serration; the length of leaf pedicle and the posture of leaf base), young P+2 shoot (pubescence density on bud and lower surface of 1st leaf; shoot colour and length; fresh and dry shoot weight; fresh/dry ratio and tannin content) and flower (flower colour; number of petal; style and flowering ability) were investigated qualitatively and quantitatively following IPGRI's guidelines. The investigated teas were grouped by hierarchical cluster analysis using the unweighted pair group method analysis (UPGMA) based on the investigated quantitative morphology data to construct dendrogram representing the relationship among cultivars and clones.

Collected data strongly approved the high diversity of investigated teas at Lam Dong based on the morphological characteristics. Results of hierarchical cluster analysis differed from traditional tea taxa, and all teas planted commonly were morphologically similar.

Keywords: *Camellia sinensis*, diversity, morphology, tea

Bt-Cotton Production in Karnataka, India

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Bollworms constitute a major target of pest management efforts in India. Bollworm resistant Bt-cotton that was approved in 2002 for commercial cultivation in India could reduce the use of pesticides and associated negative effects on human health and the ecosystems. The area under approved Bt-varieties in India has increased from about 38,500 ha in the 2002/2003 season to about 500,000 ha in 2004/2005. The recent figure equals 5 % of the total cotton area and about 11 % of the area under hybrid varieties. Studies of the economic performance of Bt-cotton in India have come to contradictory results suggesting that careful analysis of the factors determining the profitability of this new technology is required.

Most of the studies on impacts of Bt technology in India rely on cross-sectional or field trial data. The data for this study comprises a panel of 100 early adopters across 50 villages in the state of Karnataka that were surveyed in 2002/2003 and 2004/2005. In addition 50 non-adopters were surveyed in the second season. Information collected includes data on household demographics, cropping pattern, cotton production, health impairment due to pesticides and on knowledge and perception of Bt cotton. In addition, village level information was collected. Farmers' reasons for continued cultivation or disadoption after one or two years of experience with the technology are analysed. Analysis of gross margins and structure of production costs, which are examined in the context of the prevailing climatic and pest situation are compared between the two seasons and for Bt- and conventional varieties. To assess the role of the Bt trait and the productivity of other inputs production function analysis is carried out using different functional specifications within a damage control framework. The results are interpreted with regard to the agro-ecological conditions prevailing in the surveyed area.

Keywords: Bt-cotton, India, panel data, production function estimation, profitability

***Ensete ventricosum* in Ethiopia: The Need to Grow More than One Landrace**

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Ensete ventricosum (genus *Ensete*: Musaceae) serves as the staple or co-staple crop for 15–20 million people. It is grown in home gardens in southern and south-western Ethiopia under varying climates from 1300–3300 m asl. Leaf sheaths and corm provide starchy food which can be stored for long periods after fermentation. Moreover, all parts of the plant are used providing useful products for household, agriculture, and traditional medicinal treatments. Numerous landraces are cultivated.

According to folk taxonomy, landraces differ in their phenotype and in their use. Criteria for differentiation of the phenotype are size and shape of pseudostem and leaves, and colour of leaf sheaths, midribs, and lamina. Regarding human consumption, landraces are separated into three groups: (1) boiling the underneath corm, (2) extracting starch from leaf sheaths and corm for fermentation and (3) both. Furthermore, farmers prefer certain landraces for their fibre, dried leaf sheaths, animal feed, and for traditional medicinal treatments. Landraces differ in their site requirements and susceptibility to pests and diseases. Some landraces tolerate drought and frost. With rising altitude, their number declines, and only few landraces are observed in very high altitudes above 2800 metres.

The traditional groups reflect their polyphenole content. Landraces tolerant to drought, frost, and pests and diseases have a bitter taste, and are used only to produce fermented food from the leaf sheaths and corm. They are tall in size (>7 m) and provide strong fibres. On the other hand, landraces with low polyphenole content are not bitter and therefore favoured for their boiled corm. They are small (<6 m) and develop a bulbous pseudostem. However, their yield is small, and they are highly affected by drought, frost, and pests and diseases. Most medicinal landraces are included in this group. The third group shows intermediate characteristics but cannot compete with either the tolerance of the hardy landraces or the good taste of the sensitive ones. In some regions, these groups are associated with gender (male/female/intermediate).

Experiments on vegetative development and leaf anatomy confirm these traditionally identified groups.

Keywords: Anatomy, enset, *Ensete ventricosum*, Ethiopia, ethnobotany, folk taxonomy, landraces, morphology, Musaceae, Zingiberales

Genetically Modified Crops in Africa — NECOFAS's Activities on the Conflicting Issue

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Since 1996 a great number of genetically modified crops (GMC) have been released and commercialised. New cultivars of maize (*Zea mays*), soybean (*Glycine max*), cotton (*Gossypium* spp.), papaya (*Carica papaya*), tomatoes (*Lycopersicon esculentum*), canola (*Brassica napus*) and others have been developed that carry additional genes conditioning traits as herbicide tolerance, insect resistance, or virus tolerance. From 1996 to 2004 the global area of biotech crops increased from 1.7 million hectares to 81.0 million hectares. More than 34 % of the global biotech crop area in 2004, equivalent to 27.6 million hectares, was grown in developing countries where growth continues to be strong.

The Network of Ecofarming in Africa (NECOFA), founded by agricultural scientists from nine African countries in 1999 in Ethiopia, supported by Capacity Building International (InWent) and the International Centre North South Dialogue (ICNSD), declared its opinion regarding the use of GMCs in Africa. At the biannual conference 2004 in Kumasi in Ghana, where the country coordinators of all member countries (since the establishment of NECOFA, four more countries joined the network) met to exchange experiences and consider current issues, GMCs were a major point of discussion. Outcome of this conference on “Promotion of Ecofarming for Food Security, Protection of Natural Resources, Health and Income Generation” was the Kumasi declaration. Point three of the declaration claims a moratorium on the commercialisation of GMCs until: **(a)** Bio-safety regulations and policies are in place and **(b)** all environmental and health risk issues are properly and adequately assessed by competent and independent commissions. All NECOFA member countries follow that declared need for clarification on the risks of genetically modified crops in form of information campaigns. On the example of South Africa as a country that took up very fast the commercial use of GM crops, the activities of NECOFA on GMCs are presented. The poster exemplifies the content of joint campaigns with other local and national NGOs in South Africa. Also, structure and function of the NECOFA network between 13 African countries on risks of genetic erosion and crop-to-wild gene flow caused by GM crops is shown.

Keywords: Genetically modified crops, NECOFA

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Genetic Diversity of *Tadehagi triquetrum* in Northeast Viet Nam

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Tadehagi triquetrum (L.) H. Ohashi, a subshrub native to SE Asia, gained agronomic significance as forage legume because of its therapeutic uses, its capacity to provide crude protein for livestock feeding during dry seasons, and for its good adaptation to depauperate soils. Despite the ever increasing interest in conservation issues of natural resources as potential sources for novel germplasm providing answers to future challenges, little is known about genetic diversity in *T. triquetrum*. Still, information about the genetic diversity of species is essential for sustainable use and efficient conservation of plant genetic resources. *Ex situ* conservation of genetic diversity in gene banks requires a careful balance between the size of collections and the feasibility of maintaining and managing germplasm storage.

The objectives of this study were to analyse the relatedness among accessions collected in Bac Kan province, North Viet Nam in order to create baseline data for future conservation efforts. Genetic diversity was analysed using random amplified polymorphic DNA markers (RAPD) to determine extent of genetic variation between 24 *T. triquetrum* accessions.

Moderate levels of interaccession diversity, represented by 33.3 % of polymorphic fragments and an average Jaccard's similarity coefficient of 0.64, were found. UP-GMA clustering and Mantel Test did not reveal a correlation between geographic and genetic distances. Regarding the moderate level of differentiation found among accessions, a high incidence of outcrossing along with long distance seed dispersal must be assumed. Three unique markers were found in an outlier accession (accession no. 918) which may contain unique genetic characteristics and therefore should be conserved *ex situ* as a single accession. Of all other clusters, representative sub-samples should be selected or accessions bulked, for gene bank storage. If a wider range of the genetic diversity in Vietnamese *T. triquetrum* is to be explored, further collection missions should cover more extended areas with larger geographical distances.

Keywords: Genetic diversity, molecular markers, North Viet Nam, plant genetic resources conservation, RAPD, *Tadehagi triquetrum*

Ethno-Medicinal Diversity of *Tadehagi triquetrum* in Northeast Viet Nam

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Since 3–4 decades, the mountainous North of Viet Nam has been experiencing dramatic environmental and social changes which subsequently created a severe threat to the biological and cultural diversity of the region. Despite the loss of diversity, little systematic research was conducted in order to conserve plant genetic diversity. Yet, physical loss of plants and rapid transformation processes consequently lead to the loss of indigenous plant use knowledge associated with these plants.

Tadehagi triquetrum (L.) H. Ohashi was among 33 native legume species investigated in a comprehensive ethno-medicinal survey conducted among four ethnic groups, the Tay, Nung, Dao and Hmong in Bac Kan province, North Viet Nam. *T. triquetrum* provides therapeutic virtues as medicinal plant as well as livestock feed under marginal conditions and thus represents an agronomically and economically interesting species. The objective of this study, carried out in 1999–2000, was to document the indigenous knowledge about *T. triquetrum* concerning its medicinal uses as a conservation strategy of cultural diversity. A herbarium voucher containing *T. triquetrum* and other 32 wild legume species was presented to 327 households in 28 villages of Bac Kan province.

Medicinal uses attributed to *T. triquetrum* ranged from treating urinary problems, stomach ache, and diarrhoea to applications as general restorative and tonic. Medicinal uses and number of informants are listed. Ethnic groups in North Viet Nam undergo a rapid transformation process from traditional rural to a more modern, market oriented lifestyle causing the loss of ethnic authenticity and indigenous knowledge as a side effect. Thus recording the diversity of plant use knowledge of ethnic groups represents a means to prevent loss of knowledge as an essential part of cultural diversity.

Keywords: North Viet Nam, cultural diversity, ethno-medicinal diversity, indigenous knowledge, knowledge conservation, medicinal plants, *Tadehagi triquetrum*

Protein Analysis and Phosphorus Use Efficiency of Landraces and Improved Green Gram Cultivars from Myanmar

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Throughout S.E. Asia, mungbean or green gram (*Vigna radiata* L.) has been an important short-season grain legume and staple diet of man and livestock since prehistoric times. In Myanmar, green gram is an important component of the rice-based cropping system, however, current yields of around 800 kg ha⁻¹ are much below its yield potential of 3000 kg ha⁻¹. The reasons for this shortfall are as under-investigated as is the genetic response to the application of phosphorus (P) which is critically low in many Myanmar soils. For green gram quality, the concentration of lysine, an essential amino acid is particularly important given its scarcity in many cereal-based diets of Southeast Asia. The purpose of this study therefore was to investigate the effects of P application on the root and shoot growth, yield and its components for a range of green gram varieties, and to analyse the protein concentration (amino acid composition) in green gram seed. From 2001 to 2003 field experiments were conducted under rain-fed conditions in Yezin and Nyaung Oo. Fifteen landraces and five introduced green gram cultivars were grown at two level of P (0 and 15 kg ha⁻¹). There were large genotypic effects for P application on shoot and root growth and significance genotypic differences in the amino acid profile in TDM were found. One of the advantages of phosphorus application was a reduced pest and plant virus infestation. The rate and placements of phosphorus fertiliser to these promising greengram cultivars should be further studied in Myanmar with new locations.

Keywords: Green gram, Myanmar, phosphorus, protein

Investigation of Genetic Variability among Twenty Sesame (*Sesamum indicum* L.) Venezuelan Cultivars Using Amplified Fragments Length Polymorphisms (AFLP)

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Sesame (*Sesamum indicum* L.) is one of the most ancient crops. It is grown in tropical and subtropical areas on 6.5 million of hectares worldwide. Sesame seeds are highly nutritive and they are used for direct consumption and as an oil source of excellent quality. Venezuela is the 7th exporter worldwide, producing 30,000 t per year. Many cultivars have been released, however little information about the genetic variability among them has been investigated, and only information about morphological characterisation is available. The aim of this study was to determine the genetic variability among sesame Venezuelan cultivars using amplified fragment length polymorphism (AFLP). 20 cultivars were used to perform AFLP using 8 primer combinations. Jaccard's similarity coefficients and Unweighted Pair Group Method with Arithmetic Mean (UPGMA) were used in cluster analysis. Principal coordinates analysis was also performed. Genetic variability among cultivars was compared with non-commercial accessions from Venezuelan germplasm bank to know how much of the available genetic variability has been used in breeding programs. A high level of polymorphism was obtained. Of the 457 bands recorded, 87 % were polymorphic. Cluster analysis grouped 18 cultivars in two clusters, both including cultivars obtained from single populations. Principal coordinates analysis showed a continuous variation along the biplot, displaying high variability among three cultivars that come from a population formed by 50 accessions with different geographic origin. Similar results were obtained when 2 cultivars that come from a single cross were compared. This result indicates that Venezuelan breeding programs based in population formed by many accessions do not differ too much in genetic variability affecting the yield from populations resulting from single crosses. This suggests that a detailed study of one pair of parents to form one population could be more successful than to use many accessions to obtain genetic variability for selection. The comparison of genetic variability among cultivars with the variability within germplasm bank revealed that only part of the available variability has been used in sesame breeding so far. This finding implies that germplasm bank represents a potentially valuable, unexploited source of genes for improving the yield of Venezuelan cultivars.

Keywords: AFLP, cultivars, plant breeding, plant genetic resources, sesame

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Amphicarpy in Perennials: *Centrosema rotundifolium*

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Amphicarpy is an evolutionary adaptation which contributes to the increase of a plant's fitness under varying conditions. It consists of a dual reproductive strategy, with formation of subterranean seeds on specialised reproductive structures in addition to aerial seeds, on the same individual. So far, research on this phenomenon has been limited to annual species. The need for sustainable utilisation of vast marginal tropical and subtropical lands has aroused research interest in some of the 35 neotropical species of the legume genus *Centrosema*, among them amphicarpic *C. rotundifolium* Mart. ex Benth. This trailing perennial originates mainly in the northeast Brazilian "caatinga" and can survive on very dry, poor and sandy soils. Effects of two factors relevant for the use of this species, on aboveground/belowground reproductive allocation, were tested on a sandy, low-fertility soil in Venezuela: Eliminating phosphorus deficiency by fertilisation improved the overall vegetative and generative growth, but did not affect the aboveground/belowground ratio of generative matter. Competition stress, simulated by planting density, showed that aerial generative matter was negatively affected already at densities higher than 1 plant m⁻², while only a severe stress (16 plants m⁻²) induced an increase in subterranean seeds on the expense of vegetative growth. A shift in reproductive allocation in response to stress might have longer-term ecological implications. Cumulative germination of viable, unscarified seeds over a 7-month period showed conspicuous differences between two seeds types, presumably due to the structure of the testa: While all aerial seeds germinated, about 40% of subterranean seeds remained hard. The growth of plants from the two seed types under no imposed stress was analysed by nonlinear models. Phenology and general growth patterns did not differ significantly; however, plants originating from aerial seeds produced 33% more aboveground reproductive biomass than plants from subterranean seeds. Subsequently, plants from aerial seeds had a slight lag in growth of tuberous (storage) roots, and about 7% less aboveground vegetative biomass. Contrary to annual amphicarps, *C. rotundifolium* starts aerial flowering early in ontogeny. However, underground reproduction, which is delayed but has about seven times higher generative biomass, remains the major survival mechanism.

Keywords: Amphicarpy, *Centrosema rotundifolium*, resource allocation

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Inheritance of Resistance to *Aspergillus flavus* in Groundnut

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The fungus *Aspergillus flavus* strain commonly infects groundnuts (*Arachis hypogaea*) and produces a potent class of hepatocarcinogenic known as aflatoxins. Host-plant resistance to *A. flavus* infection is considered the most effective method for reducing aflatoxins, but the resistant germplasms are limited. This study was conducted to evaluate the types of gene action governing the inheritance of resistance to *A. flavus* infection at pre-harvest, by estimating combining ability in groundnut populations obtained from half-diallel crossing among 5 parental lines involving three resistant (J11, ICGX990093 and ICGX990094) and two susceptible (Khon Kaen4 and ICGV91066) groundnut genotypes. The 10 F1 hybrids and the 5 parental lines were evaluated for the quantitative character: percent-infected peg and the qualitative character: percent-infected peg area fluorescence. The results show that the general combining ability (GCA) mean squares were significant for all traits, demonstrating the variability of GCA of the parents. The specific combining ability (SCA) mean squares were only significant for percent-infected peg area fluorescence. This indicated that the importance of additive gene effects was the main cause of the observed genetic variation for percent-infected peg. However, the highly significant of GCA as well as SCA in percent-infected peg area fluorescence indicates the importance of both the additive and the non-additive gene effects. Thus, hybrid combinations with low percent-infected area fluorescence, with the favourable SCA estimates and involving at least one of the parents with high negative GCA in both quantitative and qualitative characters, would tend to increase concentration of favourable alleles, a situation of great interest to breeding for resistance to *A. flavus* infection.

Keywords: *Aspergillus flavus*, combining ability, groundnut, (*Arachis hypogaea*)

Genetic Diversity of Hexaploid Omani Wheat Landraces Detected by Microsatellite Markers

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For millennia wheat (*Triticum* sp.) has been growing in traditional aflaj-irrigation systems of remote mountain oases in northern Oman. However, little is known about the diversity of the ancient landraces used. Given initial reports about the occurrence of novel germplasm in such material, the objective of this study was to evaluate the genetic diversity of wheat landraces in relation to their geographic origin using microsatellites. The collection covered most of Northern Oman where wheat landraces are growing. Total genomic DNA was extracted from six pooled plants. A total of 161 wheat accessions were assayed using 35 microsatellite loci. A total of 305 polymorphic bands were recorded for the 35 microsatellites. The Polymorphic Information Content (PIC) across the 35 microsatellite loci ranged from 0.02 to 0.89, with an average of 0.50. A mean heterozygosity value of 0.09 was determined for the 35 microsatellites with the highest level recorded for material from the Batinah region. Specific alleles averaged 1.85 with the highest value being from the Dakhilia region. Average allele numbers were different for each region. The results indicated a significant correlation between genetic diversity and numbers of alleles across all regions. The correlation coefficient between these two variables over the 35 microsatellites loci was 0.657, whereby correlation coefficients of 0.718, 0.706, 0.657 and 0.651, respectively, were found for the Batinah, Dahirah, Dakhilia and Sharquia material. Genetic distances indicated that all landraces were closely related. The cluster analysis discriminated most of the landraces accessions, however, failed to group the landraces site-specifically. The present study demonstrated the presence of high diversity in Omani landraces and also indicated the effectiveness of microsatellites to describe it.

Keywords: Mountain oases, *Triticum* spp.

Gene Flow and its Effect on Agrobiodiversity: Common Bean as a Model for Future Considerations in Biosafety

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The genetic compatibility between crops and their wild relatives has important implications for conservation of genetic diversity and for the introduction and management of transgenic crops. The gene flow event, distribution of receptor populations, gene transfer effectiveness, pollination activity and long-term effects (namely in fitness) are being studied in natural populations of common bean in a centre of origin and genetic diversity.

Our project has been conducted since 1987 in populations of *Phaseolus vulgaris* in central Costa Rica with financial support of the Bundesministerium für Wirtschaftliche Zusammenarbeit und Entwicklung (BMZ) of Germany. We documented the geographical distribution of each wild population and the biological complexes of “wild-weedy-cultivated” materials. Twenty-two populations of wild common bean are known for Costa Rica, and distributed in four watersheds in the central part representing at least 90 % of the possibly existing populations.

For the disclosure of wild populations, we applied a technique of ecogeographic surveying. For the molecular characterisation, 1,232 individuals were selected based on a morphoagronomic evaluation, and 417 of them were weedy types possibly resulting from gene flow event. We used phaseolin, isozymes, and microsatellites as markers. The gene flow direction was detected by RFLPs-PCR, sequencing and SNPs on chloroplast-DNA.

The data analysis showed that 98 % of the individuals were indeed hybrids. The direction of gene flow was mainly wild pollen towards the cultivated materials (82 %). However, the other direction was observed at lower but significant percentage. The gene flow was mostly in materials belonging to the Mesoamerican gene pool. However, outcrossing between Mesoamerican and Andean gene pools were evidenced in 8 % of the weedy individuals.

Our results provide an update about the distribution of wild common bean in Costa Rica, its ecology and conservation status. Additionally, they allowed us to reliably establish the existence of simple or complex events of gene flow among different biological forms. Obviously, domestication has not yet altered the reproductive system of *P. vulgaris* up to prevent gene exchange between such forms. This in turn is also important for the production of certified seeds, or the management of genetic resources on-farm.

Keywords: Introgression, outcrossing, *Phaseolus vulgaris*, SNPs, SSRs

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Productivity Growth of Smallholder Sugarcane Farms in Kenya: A Data Envelopment Analysis (DEA) Decomposition

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Studies on Kenyan agriculture show that while production and input use have grown, productivity has stagnated. This includes the sugar sub-sector, which holds a key position in the Kenyan agricultural sector. Statistics from the Kenya Sugar Board (KSB) (2003), show declining cane yields from 1997 to 2000. It's against this background that we carried out this study in three sugar schemes in Kenya. The objective was to determine the total factor productivities among smallholder sugarcane farms between two plant-crop periods. A total sample of 95 farms was considered in our study. Mumias scheme had 41 farmers, Chemelil had 28, while west Kenya recorded 26 farms. This study uses the Malmquist Total Factor Productivity (TFP) Index. The advantage of this methodology is that it decomposes TFP into its efficiency and technological change components, and this makes it easier to identify the areas of emphasis when tackling the issue of productivity. Results show TFP values of 0.984, 0.880 and 0.982 for Mumias, Chemelil and West-Kenya schemes respectively, while the overall TFP change was 0.947. This is an indication that, for the combined schemes, TFP declined by 5.3 % between the two periods. Depending on the scheme however, the decline could be attributed to either technological or efficiency regress. In the decomposed form, the efficiency change in Mumias was 1.011 while the technological change was 0.973. Chemelil had an efficiency change of 0.947 and a technological change of 0.929, while west Kenya recorded efficiency and technological changes of 0.962 and 0.993 respectively. These measures give an indication of the target areas of policy intervention in each scheme, but in the overall, sugarcane farming in Kenya is faced by both efficiency and technological problems.

Keywords: Efficiency change, Malmquist TFP index, technological change, total factor productivity

A Decision Support System for Determining the Effect of Seeding Rate on Crop Yield

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The rapidly growing demand for the application of information technology have induced managers, farmers and policy makers to question the advantages and the performances of these systems.

In Sudan the information systems application started to grow in the last few years, specially systems designed to automate payroll, accounts payable, inventories control and other old ideas in the domain of international computer software application. However, agricultural and environmental information technology applications and decision support systems (DSS) are suffering from stagnancy. Moreover, it was found that the agricultural, environmental and resource management researchers suffer from the insufficiency of information technology applications and computer software support especially during the period of research preparation and results calculation. All the mentioned causes waste a lot of time and effort as after designing the experiment, collecting the raw data and during the stage of decision creation, the data manipulation is done manually. So the degree of accuracy, reliability and promptness achieved from these calculations, gives no satisfaction.

This study constructs a DSS to support agronomists, stands for their ideas and helps them in determining the better level of one parameter out of two parameters applied in the field. The objectives of this study are to: accurate and simplify the data entry; organise and simplify the process of data showing during entering and after entering; reproduce represent tables and calculate the vertical and horizontal totals and means as desired for scientific papers; give consecutive steps and information that help computer-ignorant researchers to execute different stages in order to support them with their decision finding for the best seeding rate that is suitable at the specified circumstances of the field.

Keywords: agricultural information systems, split-plot design

Analysis of Technical Efficiency of Irrigated Rice Production System in Myanmar

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Agriculture sector in Myanmar occupies a dominant position in the development of national economy of Myanmar. Agriculture Service of Myanmar not only provides the high yielding varieties and proven technologies but also organises the diffusion process of these the technologies to the farmers. This study was conducted to examine the technical efficiency of irrigated rice production system in Myanmar. The data were collected by personal interviews and questionnaire from random sample of 144 farmers in central part of Myanmar. In this study, problems for area expansion and increasing yield were identified. According to the results of survey, the most important problems were high price of fertiliser, shortage of irrigated water, limited money and poor technical knowledge on plant protection and availability of information on obtaining HYV seeds.

In the estimation of stochastic frontier production function, increasing use of not only family labour but also urea fertiliser would significantly lead to increase the yield level of small farm size group. In the medium farm size, level of education was negatively and significantly related to technical inefficiency at 5 percent level. Therefore, more educated medium farmers seem to be more technically efficient in irrigated rice production. The large farm size group had the highest technical efficiency score 0.77 followed by medium and small farm size groups under the present technology. There was a large proportion (85 %) of small farmers who had lower levels (<0.75) of technical efficiency score.

Having higher technical efficiency, two things should be considered in the improvement of irrigated rice yield. On one hand, the government should continue to increase its support for public investment in infrastructure and technology such as roads, irrigation, research and extension. On the other, increased production and efficiency of production can be achieved by increased application of urea fertiliser and family labour presently being used and education level should be raised to increase the technical efficiency of medium farm size group.

Keywords: Constraints, irrigated rice, Myanmar, stochastic frontier, technical efficiency

Climatic Zoning for Upland Rice in Brazil: Economic, Social and Environmental Impacts

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The intensive expansion of agriculture in Brazil occurred in the seventies when extensive areas of the “Cerrado” and part of the Amazon region were occupied. In this process upland rice was one of the most important crops due to its easy adaptation to soil conditions and the use of little mechanisation. Yield losses often occurred due to the climatic variations, limiting the sustainability of the crop. In 1997, the climatic zoning for upland rice cultivation, to identify areas with lower climatic risk and the best sowing time, was offered by Embrapa. Additionally, the climatic zoning serves as tool to assist the government for the allocation of resources in regions with better ability to produce upland rice. Since 2001, this agricultural innovation is being submitted to economic, social and environmental impact assessment. The methodologies used are the Economic Surplus Method for economic impacts, and the AMBITEC system for social and environmental impacts. The AMBITEC is composed of a set of electronic spreadsheets built to consider different aspects that contribute to a given technology. The resulting impact index can vary from -15 (very undesirable impact) to +15 (very desirable impact). In 2004 the adoption of the climatic zoning for upland rice cultivation generated, in 2004, a surplus of US\$ 5.6 million; corresponding to an additional harvest of 29.3 thousand tonnes of paddy rice, in the States where the technology was adopted. In the social scope, the main benefits were the generation of jobs and an increase in food supply in the domestic market. The social impact index was 0.61. In the environmental scope, the technology contributed to reduce the use of pesticides, energy, and incorporation of new land (deforestation) for rice cultivation. Climatic zoning allows to choose areas with low risk of drought, using less energy with re-sowing and spraying operations. The environmental impact index obtained by the technology was 3.4.

Keywords: AMBITEC system, climatic zoning, economic surplus method, impact assessment, upland rice

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Energy Balance of Wheat Production in Morocco

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Energy use in agriculture has recovered an increasing interest since the first energy crisis in the early seventies. The ration of energy that goes in agricultural production is less than 5 % for the industrial countries. In developing countries this percentage is probably higher due to a lower level of industrial activities. Therefore, energy saving possibilities are of high interest.

In Morocco, the most planted crop is soft wheat with 1.75 million ha (2.3 million tonnes produced, about 38 % of the annual consumption) in 2001/02. The major part of this production is mechanised using small and medium size tractors and machines.

The objective of this paper is to assess the energy balance of winter wheat production under Moroccan conditions and to investigate energy saving possibilities.

An average field operation itinerary was considered and characterised using results of own research and values from specialised literature world wide. Energy coefficient values are estimated and assumptions are admitted to ensure objective comparison with similar wheat balances under other latitudes.

The energy balance is established considering several forms of energy such as muscle energy, energy content of inputs (fertilisers, seeds, . . .), fuels, and machines. In addition the balance gives the needed energy for each field operation and each input, so that comparisons could be made from several points of view.

The analysis of the energy balance shows that the largest energy consumer is fertilisation. It contributes to the total energy use at more than 20 %. The N-fertiliser alone enters for more than 50 % of the fertiliser energy expenditure. Direct energy in the form of fuel and lubricants contributes to less than 10 % of the total energy needed for wheat production.

The basic technical itinerary can be improved by introducing practices such as manure spreading to reduce chemical N-fertiliser application and combination of operations to decrease fuel consumption and to avoid soil densification.

Compared to other countries, wheat production in Morocco needs a minimum energy expenditure due to the fact that farmers do not use fertilisers correctly. Some basic operations are not executed at all, such as pest control.

Keywords: Energy balance, Morocco, wheat production

Food Security as an Objective of Multipurpose Forage Crops in Central-America

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Although it is widely recognised that multipurpose forage crops can play an important role in improving the environmental and socio-economic sustainability of smallholder production systems in fragile environments, adoption of especially legumes has been generally low.

However, a participatory research effort in Honduras showed that forage legumes had a good potential to be accepted especially by poor farmers when, amongst soil fertility enhancement and fodder production, food security was addressed as well.

About 150 farmers with different levels of resource endowment representing the typical maize and beans based agricultural system of central Honduras conducted over 100 experiments in their own fields with grasses, shrubs and leguminous crops (mainly several varieties of cowpea, *Vigna unguiculata*). Around half of the participating farmers were women. The choice of research methods and parameters was determined simultaneously by both farmers and researchers. Dichotomous logistic regression models were used to examine the variables influencing the inclusion of feed, food and soil fertility as objectives on the one hand and determining the factors influencing adoption on the other.

Poorer farmers at high altitudes were 43 % more likely to include food production as an objective of forage crops than richer farmers in lower areas. Full or semi landownership increased the chance of food production as main objective by 31 %. Farmers using inputs like fertiliser were significantly less likely to include food production as an important objective for forage crops.

Cowpea was identified as the most promising forage legume. Reasons for continuing growing cowpea in the next growing season were its use as a food at household level, its perceived potential as a cash crop and its ability to improve soil fertility (increasing the chance of cowpea to be adopted by 38 %, 37 % and 53 % respectively).

Results also indicate that farmers tend to amplify in more income oriented issues once food security has been achieved. For instance, fodder (hay, silage) and livestock production can be developed as an important farm component to offer a valuable potential for intensification and income generating opportunities (market linkage).

Keywords: Central-America, food security, multipurpose forages, participatory research

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Optimal Management of Mycotoxins for Improving Food Safety and Trade of Maize in West Africa

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Mycotoxin-producing fungi can infect grains from pre-harvest in the field to post-harvest in the stores. In Benin and Togo (West Africa), aflatoxin levels in maize averaged five times the safe limit in up to 30 % of household grain stores. As a result, farmers and consumers are being exposed to high levels of aflatoxins and other mycotoxins. Studies have shown that 99 % of fully weaned children had nearly 2-fold higher aflatoxin-albumin adduct levels compared to those breast-fed. The International Institute of Tropical Agriculture (IITA) recognises mycotoxins as an important constraint to improving human health and well being of African people and enhancing African trade internationally.

Based on past work by IITA and its collaborators, several pre- and post-harvest strategies are being developed and tested to reduce risks of aflatoxin and fumonisin contamination. These strategies include the use of resistant and/or tolerant varieties, biological control, appropriate postharvest handling (sorting, cleaning, drying, good packaging, application of hygiene, use of appropriate storage systems, appropriate transportation means), awareness and sensitisation on the impact of mycotoxin contamination on human, animal health and trade, promotion of management practices that reduce mycotoxins in food products and the use of appropriate pesticides on food products during storage. Appropriate technologies for processing food in rural areas and their efficacy in reducing toxin contamination are being evaluated. Work continues to focus on food basket surveys, bio-ecology of aflatoxin production, biological control through competitive exclusion strategy, and resistance breeding. Furthermore, strategies to reduce impact of mycotoxin on regional and international trade need investigations.

Keywords: Food safety, maize, management, mycotoxins, trade

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Alternative Crops for Sustainable Rural Development — A Socioeconomic Evaluation of the Possibilities for Growing *Aloe vera* in Northern Mexico

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Since Mexico has signed the North American Free Trade Agreement (NAFTA), the structure of the rural economy is severely changing. 25 % of the population still draws their incomes from farming activities. In addition to political changes, farmers of arid regions in Northern Mexico face an increasing water scarcity and thus land degradation. Reasons for that is an inadequate use of regional water resources as well as decreasing precipitation. Both, scarcity of water and the lack of other possibilities to increase productivity have caused problems such as poverty, land retirement and migration. Many of the small scale farmers are forced to search for alternative crops and non-agricultural income.

Aloe vera is one of the most suitable plants due to its ecological adaptation to arid regions and to its increasing demand on global markets. The investigation of the potential of Aloe in Northern Mexico was linked to an already existing pilot project of the University of Chapingo, Mexico, dealing with sustainable rural development.

Compared with other regional crops Aloe was found to have both ecologic and economic advantages due to its high water use efficiency and high yields per hectare. Because of its drought resistance Aloe can also be integrated into agro forestry systems to stem desertification. Furthermore there is an increasing demand for organically grown Aloe on global markets which carries higher product prices.

The study also showed that for continuous production small scale farmers need free access to consulting, irrigation and financing.

The principal demand for Aloe products is still to be found in more developed countries. The study shows that it is difficult for small farmers to enter and to remain on global markets. Intensifying the transfer of knowledge between research and farmers could however, significantly increase the potential for regional and national commercialisation.

Keywords: *Aloe vera*, arid regions, commercialisation, Mexico, production characteristics, small scale farmers

Participatory Evaluation of Cowpea (*Vigna unguiculata*) and Lablab (*Lablab purpureus*) for Vegetable Use in Eastern Africa

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Traditional African vegetables have long been neglected in research and development and are at risk of genetic erosion because of the introduction of new vegetables to the region. In collaboration with The World Vegetable Center's Regional Center for Africa (AVRDC-RCA) located in Arusha, Tanzania, germplasm collections of cowpea (*Vigna unguiculata* (L.) Walp.) and lablab (*Lablab purpureus* (L.) Sweet) have been agronomically evaluated. However, for achieving the adoption of a new variety to be released, it is important not only to assess the yield potential, but also know the feelings, perceptions and preferences of farmers, extension workers and consumers at the early stage of developing that variety. The role of participatory selection is essential especially for new crops or new products from a known crop. In line with this concept, a participatory visual evaluation of a number of cowpea accessions was conducted in the fields of AVRDC-RCA, for assessing their suitability in making a meal from seed or leaf. Lablab accessions were evaluated in the same way for their suitability of leaves and pods as vegetable. Leaves of both cowpea and lablab as well as lablab pods were cooked and evaluated by farmers drawn from different districts of Arusha, Tanzania and extension workers from Malawi, Rwanda, Uganda and Tanzania. The preference probability at a given preference/taste level was calculated and showed that participants have ranked the available accessions differently for different traits of relevance as a vegetable. Spearman's rank correlation coefficient was calculated, but no correlation was found between traits assessed in cowpea or lablab accessions. This shows that farmers' and/or consumers' needs are diverse and suggest breeding to be performed separately for various traits, if economical. Otherwise, any new variety should be developed by accommodating the major traits of interest if multipurpose use is planned. In addition to identifying participants' needs, participatory evaluation was used as a tool to popularize lablab as a neglected crop with an immense potential as a vegetable.

Keywords: Cowpea, East Africa, *Lablab purpureus*, legume, participatory evaluation, vegetable

Do Specialty Coffees Increase Farm Gate Prices? An Analysis of the Marketing Behaviour of Coffee Farmers in Costa Rica

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Since the abolition of the International Coffee Agreement in 1989 and the subsequent increase in supply, world market coffee prices became more volatile and since 1998 have sharply declined. In an attempt to overcome the crisis of low coffee prices the Costa Rican government launched a programme to promote quality enhancing practices in the coffee sector. To achieve high quality coffee beans, the measures must be implemented at all levels of the product chain. The present study aims to find out whether improved coffee quality translates into higher farm gate prices for the farmer and which other marketing strategies and household specific characteristics allow farmers to obtain better prices for their coffee.

Results from a regression model show that farmers who market their coffee under the label of specialty coffee obtain a significantly higher average price for their produce than farmers who sell their coffee as conventional coffee. Even controlling for these differences in coffee quality, the marketing channel matters. Farmers who are members of cooperatives get higher prices for their coffee than farmers who sell to private mills. Furthermore, access to information is an important asset to make improved marketing decisions. The analysis shows that if the selection of the buyer is based on geographic proximity, average prices are clearly lower. On the other hand, if the decision is based on trust and good experience with the mill, prices received tend to be higher. Concerning price information, the source is critical. Some sources seem to be more reliable than others and information obtained from reliable sources translates into higher coffee prices received by the farmer. The results of the study suggest that the policy of fostering quality standards in coffee production is beneficial at the farmer level in terms of higher average prices received. Further policy recommendations derived by the study refer to the support of coffee related organisations and access to reliable information.

Keywords: Coffee prices, Costa Rica, marketing channels, marketing strategies, quality standards

Effect of Bee Pollination on Seed Set and Nutrition on Okra (*Abelmoschus esculentus*) in Cameroon

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The study was conducted from June 2004 to August 2004 at the out sketch of Yaounde (Cameroon). Okra (*Abelmoschus esculentus*), Malvaceae, is a native of West Africa. It has a considerable economic importance because the seeds and pods are used for food. Hand and insect pollination of okra flowers gave seed sets varying between 73–84 % per pod which differ significantly ($p < 0.05$) from that of the bagged flowers (spontaneous self pollination) which just rendered 57 % seed sets per pod. An increase of 10.3 % in seed sets from cross pollination over forced-self pollination and a 16 % increase in seed sets was recorded from forced-self pollination over spontaneous-self pollinated flowers. Noteworthy, that a fecundated seed contains 91.5 μg nitrogen whereas an unfecundated seed has only 2.6 μg nitrogen; this means that a fecundated seeds contains 35 times much more nitrogen. As a consequence, cross-pollinated flowers rendered more fecundated seeds; with 311.1 μg more nitrogen per carpel than seeds from spontaneous-self pollinated flowers with more unfecundated seeds. An increase of 754.1 μg carbons and 192.2 μg of nitrogen per carpel were noted comparing seeds from forced self-pollinated flowers with those from spontaneous self-pollinated flowers. This demonstrates the need for cross-pollination in the okra garden to achieve optimum yields both in both seed quality and seed sets. Observation of 829 individual bees of at least 4 different species visiting okra flowers indicates that *Megachile* sp. had more contacts with the stigma upon landing (56.1 %), thus, it possibly does cross pollination. *Halictus* spp. are considered potential pollinators for self-pollination, as they frequently roll on the anthers and consequently on the stigma of the same flower (86.3 %) before taking off. *Xylocopa* sp. is a pollen thief, as it visits okra flower just to collect pollen but does not aid in pollination. *Apis mellifera* is mainly a nectar collector in okra flowers.

Keywords: Bee pollination, nutrition, Okra (*Abelmoschus esculentus*), seed set

Aflatoxin Producers from Soil of Maize Producing Regions in Nigeria

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Aflatoxins are toxic fungal metabolites produced by several members of *Aspergillus* section Flavi. Aflatoxin producing fungi disperse from the soil to infest maize crops on which they frequently cause aflatoxin contamination both in the field and in storage. Several aflatoxin producing species are known to occur in West Africa, but the frequencies and distributions of these strains in the major maize producing regions of Nigeria were previously unknown. Over 1,000 fungal isolates of *Aspergillus* section Flavi were collected from the soil by dilution plating of 51 soil samples from Nigerian maize fields onto a modified Rose Bengal agar. Section Flavi averaged 1159 colony forming units (CFU) per g soil and ranged from 2 to 16,660 CFU g⁻¹. The L morphotype of *A. flavus* occurred in all samples, whereas the S morphotype occurred in only 19 samples, but was present in every district, ranging from 0 to 45 % of the fungi isolated. The highest S strain incidence was found in the Lafia district, and the lowest incidence was in the districts of Ogbomosho and Ado-Ekiti. Soil pH of the sampled soils ranged from 5.1 to 8.7 pH. Isolates varied widely in ability to produce both aflatoxins and sclerotia. Both the shape and size of sclerotia varied with some *A. flavus* strains tending to produce sclerotia embedded in the substrate. The importance of sclerotia embedded in substrates to the potential toxicity of *A. flavus* strains on crops should be considered. The distribution of aflatoxin-producing species in soils will be contrasted with the frequencies on crops grown in the sampled fields.

Keywords: Aflatoxin, *Aspergillus flavus*, sclerotia, soil

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Effect of Anomalous Pollen Grains of Sweet Cherry (*Prunus avium*) on Larval Development of the Wildbee *Osmia cornuta*

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We investigated the effect of anomalous empty pollen grains of five sweet cherry cultivars (Kordia, Oktavia, Regina, Sam, Schneiders) on the larval development of *Osmia cornuta* wildbees. Dead pollen is found in different amounts among sweet cherry cultivars: Kordia (62 % empty pollen per anther), Oktavia (49 %), Schneiders (32 %), Regina (24 %) and Sam (17 %). In wildbees, food provision to larvae consists in a limited amount of pollen. Provision amount differs between males and females, but in all cases, once load is provided, broodcells are sealed and no further provision events occur. Consequently, mixed loads of dead and alive pollen may lead to maldevelopment, abnormal adult size or larval death. The hypothesis of higher intake of empty pollen grains increasing occurrence of larval malformation or death is tested. Pollen quality of pure cultivars is considered: *O. cornuta* individuals providing their broodcells with pollen offered by isolated cherry trees. This study was performed during the 2005 blossom period of cherry trees, at the University-of-Bonn experimental station "Obstversuchsanlage-Klein-Altendorf," Meckenheim, Nordrhein-Westfalen, Germany. Known number of wildbees were released into cages, of isolated trees, per cherry cultivar. Nesting places (trapnests) and constructing material were provided. Intact broodcell provision was obtained by removing egg. Complete larval development was recorded or until death. Results include the effect of pollen provision in broodcells on mortality rate and larval maldevelopment. Quantification of anomalous and normal pollen grains of food provision in broodcells are presented. Discussion includes the effect of pollen quality on mortality rate in those cultivars with the highest number of empty pollen grains provided to *O. cornuta* larvae. Pollination efficiency, survival and reproductive success of malnourished wildbees are discussed. To date, emphasis has been placed on increasing produce quality in orchards, but no attention has been given to germinable cells of trees. Pollen quality has paramount importance to the sustained cultivation of orchard trees. The occurrence of pollen grains of lower quality may pose detrimental consequences to the nourishment of larvae of potential pollinators in orchards too.

Keywords: Empty pollen grains, larval development, *Osmia cornuta* wildbees, pollen provision in broodcells, sweet cherry

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Assessing the Sustainability of a Wheat-Based Cropping System under Mediterranean Conditions

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In this study, we demonstrate the usefulness of the Agricultural Production Systems Simulator (APSIM) in examining prospects for enhancing the sustainability and productivity of a wheat-chickpea rotation at Tel Hadya, northwest Syria. The analysis included daily weather data from 1979 to 2002 and 5 nitrogen (N) fertiliser (0, 30 to 120 kg N ha⁻¹ to wheat only) x 3 tillage/residue management combinations (CT, conventional tillage: deep ploughing at 30 cm depth; MT, mulch-tillage: non-inversive with a residue mulch left on the soil surface; BCT, conventional tillage with stubble burning after wheat).

Ecological and economical indicators for monitoring changes in the sustainability of the system were yield, water use efficiency (WUE, ratio of yield to evapotranspiration), soil organic matter (SOM) and gross margin (GM). A management system was considered sustainable if the values of the selected indicators were maintained or enhanced over the simulated timeframe of 23 years and relative to a baseline system.

Mulch-tillage outperformed CT and BCT for all selected sustainability indicators. This indicates that MT has the potential to enhance the sustainability of a wheat-based system in northwest Syria. Simulated soil water was higher under MT compared to CT and BCT, which resulted in improved yield and WUE. The mean gain in wheat (60 kg N ha⁻¹ applied) and chickpea yield was about 0.5 t ha⁻¹ and about 0.4 t ha⁻¹. Stubble burning after wheat (BCT) had no effect on SOM, but led to lower GM compared to CT and MT as there was no revenue from sold straw or benefit from soil water conservation. Both the amount of N fertiliser and retained crop residues increased SOM, though the long-term response of SOM to management did not exceed 0.3 % (0–30 cm depth).

APSIM proved suitable for monitoring and quantifying changes in selected sustainability indicators. However, the choice of indicators is predefined by the capabilities of the model. Pests and diseases, for example, are not simulated. Despite this limitation, systems simulation allows us to objectively examine long-term, future impacts of alternative interventions across the range of expected weather variability in a manner that is not possible with empirical approaches.

Keywords: APSIM, chickpea, rotation, sustainability, wheat

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Traditional Management and Use of Yams (*Dioscorea* spp.) in Wolayita, Southern Ethiopia

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Yams (*Dioscorea* spp.) are widely distributed throughout the tropics and sub-tropics. They are cultivated by subsistence farmers in the southern, south-western and western parts of Ethiopia across a range of agro-ecologies. Some species are also found in the wild and often collected for food in various localities. Nevertheless, researchers and policy makers have largely neglected yams and no attempt was made to systematically study their significance in the farming system and identify existing potential for crop improvement.

As part of an ongoing study to characterise diversity in yams, this survey was conducted in Wolayita zone, southern Ethiopia, to investigate the existing yam production system and farmers' perceptions and management of the crop. The study area was stratified according to geographic distance and altitude to cover the geographic range of yams. A household survey was conducted using structured and semi-structured questionnaire and 320 households were interviewed during the 2003/2004-cropping season. Data was collected on production methods, current trends, production constraints, and uses.

Results indicate that yam is highly valued by Wolayita farmers and managed accordingly to meet their needs. Planting is mainly in October, at the onset of the dry season and making use of soil moisture reserves from the preceding rains. Early maturing cultivars are ready for first harvesting from May and fill seasonal gaps in food supply. The main production constraints are small landholding, laboriousness of the production system, scarcity of staking materials, and shortage of seed tubers for planting. Nonetheless, yam is establishing itself as an important cash crop in most localities. More importantly, it is the preferred food for honoured guests and served during the main traditional celebration (*Meskel*) that coincides with the peak of harvesting, fetching high prices on markets.

The study showed the persistent farmers' interest in producing and utilising yams despite lack of support in any form. There exists a potential to improve the crop through a good understanding of how farmers manage and use diversity, and proper characterisation and evaluation of the existing germplasm. This will undoubtedly increase the role of yams in addressing food security both at household and national level.

Keywords: *Dioscorea* spp., traditional management, utilisation, yam

Consumer Preferences and Importance of Food Crops Like Rice and Beans in Brazil

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In many countries, rice and beans are traditional food crops being widely produced and consumed. Thus only a small portion of the production is exported. In Brazil, the rice and beans production is not enough to satisfy the domestic demand. But how large is this domestic demand for rice and beans? Who is demanding what and how much? How much are Brazilian citizens spending to acquire food e.g. on rice and beans?

The objective of this study is to report the behaviour of the domestic market for food crops like rice and beans, and the consumption habits of Brazilians, exploring data from the national household budgets survey from 1995–1996 and 2002–2003. In that period there were some changes in household expenditures. The amount of household income spent on food increased from 16.4 % in 1995–1996 to 17.1 % in 2002–2003 mainly due to income reduction. The minimum wage dropped from US\$ 115.3 in December 1995 to US\$ 56.5 in December 2002. This real income reduction also increased the pressure of utilities on household budgets from 20.8 % in 1995–1996 to 29.3 % in 2002–2003, and of commuting from 9.7 % to 15.2 % in the same period.

The annual per capita consumption of polished rice — main consumption form — is about 25 kg, varying from 18 kg in the South to 36 kg in the Central West region. The annual per capita consumption of beans is about 13 kg, varying from 10 kg in the South to 18 kg in the Northeast region. The per capita consumption of rice and beans is higher in lower income classes. Rice participates in total caloric intakes with about 18.8 % (varies from 8.9 % in Pernambuco to 39.6 % in Maranhão) while beans represent just 6.7 % (varies from 4.2 % in Santa Catarina to 12.0 % in Paraíba) of total caloric intake of Brazilians.

Keywords: Beans, consumer preferences, household expenditures, national household budgets survey, per capita consumption, rice

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Exploitation of Natural Resources for Food Security in Developing Countries

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Common Beans (*Phaseolus vulgaris* L., Fabaceae) are among the most important food legumes worldwide, providing one of the primary sources of dietary protein, particularly in developing countries. Stored legumes are endangered by bruchids (Coleoptera) throughout the tropical belt, with the Common Bean Weevil, *Acanthoscelides obtectus* (Say) and the Mexican Bean Weevil, *Zabrotes subfasciatus* (Boheman), being the major storage pests. Post-harvest losses are particularly critical, as all investments for growing the crop have already been made at this stage. An integrated pest management strategy for safe storage could generate a better income for small-scale farmers and reduce human mal- and under-nutrition. While host-plant resistance was found to be a powerful tool against *Z. subfasciatus*, solutions for *A. obtectus* remain to be developed.

Recent studies indicate that the combination of certain bean characteristics and biological control by the parasitic wasp *Dinarmus basalis* Rond. (Pteromalidae) is a promising integrated approach to control *A. obtectus*. By studying the tritrophic system of bean, beetle and parasitoid, we investigate which plant traits are optimal in combination with the parasitoid to suppress beetle damage. The natural storage protein arcelin strongly influences the development of the bruchid *A. obtectus*. Besides the time required for completing the development of *A. obtectus*, the observation of a prolonged emergence period under arcelin regime is also valuable. In regard to bio-control by its larval parasitoid *D. basalis* both findings implicate that suitable host stages for parasitisation are available over a longer period of time.

Our studies aim to quantify the effect of certain key parameters of dry beans on *A. obtectus* and its natural enemy *D. basalis*, and to find the combination of certain host plant features that yields best results in suppressing beetle damage due to the favourable tritrophic interactions.

Keywords: *Acanthoscelides obtectus*, *Dinarmus basalis*, *Phaseolus vulgaris*, arcelin, tritrophic interactions

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Approaches to Successful Development of Low-Cost Fruit Juice Extraction Technologies: A Case Study to Improved Rural Livelihood in Malawi

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Fruits, in Malawi, are available ranging from mangoes (Kalisere and Boloma), water melon, guava, pineapples, paw paw, oranges, tomatoes, tangerines, baobab fruit and many other indigenous fruits. Production is estimated up to 75,000 metric tons per year. Unfortunately, post harvest losses account for over 60 % due to fruit perishability, poor marketing and lack of post harvest processing techniques strategic to product development for adding value. Two simple hand-operated low-cost Horizontal and Vertical Fruit Juice Extractors were developed to increase utilisation and minimise post harvest fruit losses in rural areas of the country. Performance evaluations on both machines were conducted on-station and on-farm in terms of: extraction capacity, efficiency, fruit-seed breakage, power requirement, rest period and economic analysis was also carried out. A split plot design with two treatments replicated three times; machine types- horizontal versus vertical (T1), fruit variety (T2) were used in which 12 kg fruit sample was used in each turn. The data recorded and analysed showed that both machines were able to extract juice from various fruits at zero seed breakage and reasonable capacity, efficiency, power requirement and rest period achieving $11\text{--}15\text{ l h}^{-1}$ at 75–80 %, 52–60 W and $240\text{--}263\text{ min h}^{-1}$ compared to $15\text{--}17\text{ l h}^{-1}$ at 78–84 %, 45–50 W and $300\text{--}340\text{ min h}^{-1}$ for peeled Kalisere mango variety and $15\text{--}20\text{ l h}^{-1}$ at 80–85 %, 50–55 W and $267\text{--}300\text{ min h}^{-1}$ compared to $18\text{--}20\text{ l h}^{-1}$ at 83–86 %, 40–45 W and $340\text{--}390\text{ min h}^{-1}$ with peeled Boloma mango variety respectively. In case of other fruits, a similar trend was drawn: $5\text{--}35\text{ l h}^{-1}$ at 60–80 %, 9–30 W and $570\text{--}1900\text{ min h}^{-1}$ compared to $6\text{--}60\text{ l h}^{-1}$ at 65–85 %, 7–17 W and $1006\text{--}2443\text{ min h}^{-1}$ respectively. As it is naturally difficult to store fresh and ripe fruits under rural conditions for more than 2–3 days, this study showed fruit juice offers increased utilisation and benefits i.e. nutrition, longer shelf life (90 to 120 days), economic returns (IRR of over 60 %) for improved rural livelihood and hence reduced post harvest losses of fruits' varieties. Rural communities in Malawi are so far adopting the technology.

Keywords: Equipment, extraction, fruits, juice, Malawi, packaging, processing

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Effect of Radio Frequency Technique on Nutrient Quality and Destruction of Trypsin Inhibitor in Soybean

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Several heating methods are used in practice to destroy trypsin inhibitor in order to improve nutritive value of soybean which is a major source of protein in animal feed. This experiment was conducted to investigate the effect of radio frequency technique, a dielectric heating, on nutrient quality and destruction of trypsin inhibitor in soybean. Soybean used in this study was ChiangMai 60 variety. Six groups of the soybean were irradiated with radio frequency at 27.12 MHz. The defined target temperatures were 80 °C, 100 °C and 120 °C and holding on constant for defined processing time 90 and 180 seconds. The results of chemical analysis showed that untreated soybean contained ash, crude protein, ether extract, crude fibre, and nitrogen free extract 5.23, 37.60, 18.92, 6.15 and 23.32 % DM respectively. The chemical composition of untreated soybean was similar to those of the soybean treated with radio frequency. Thus, radio frequency had no effect on chemical composition of the soybean. All soybean samples had similar amount of acid value which indicated that radio frequency did not affect oil quality of the soybean. The result of trypsin inhibitor analysis showed that raw soybean contained 28.75 mg trypsin inhibitor (TIU) which was higher than those of radio frequency treatment at 80 °C, 100 °C and 120 °C at 90 and 120 seconds (9.70, 9.59, 8.98 and 8.80, 8.42, 7.88 TIU mg⁻¹ respectively). Increasing of the temperature and processing time resulted in decreasing trypsin inhibitor. It can be concluded that radio frequency may introduce a new aspect in feed processing technique to improve nutrient quality of soybean by destruction of trypsin inhibitor without adverse effect on other nutrients composition.

Keywords: Acid value, chemical composition, radio frequency, soybean, trypsin inhibitor

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Aromatic Thai Rice Identification by Near-Infrared Reflectance Spectroscopy

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Several varieties of aromatic rice have been released in Thailand. A rapid and high accuracy technique to identify each variety of these groups of rice is not available. Therefore, it is urgent need to both research and industry scale to verify their varieties. Based on cooking properties, aromatic Thai rice varieties show differences in their physicochemical properties. These rice properties could be determined by near-infrared (NIR) spectroscopy. The aim of this study was to determine the feasibility of using NIRS to identify aromatic Thai rice varieties.

Five selected aromatic Thai rice varieties have been milled and their qualities were determined at the Postharvest Technology Institute, Chiang Mai University, Thailand. Whole grains were scanned (1100–2500nm) in reflectance mode by spinning module. There was a satisfied result, since the NIRS spectrum could obviously identify var. Pathumthani 1 (PTN1) and var. KDML105 from other varieties by applying principle component analysis (PCA). Principle Component (PC) 1 and 3 showed better results in separating rice varieties than PC2. The PCA score plots were clear to identify differences in quality of RD15, PTN1 and KDML105. However, var. Khlongluang1 (KL1) and var. Homsuphan (HSP) showed similar values which means that KL1 and HSP varieties had similar physicochemical qualities. However, after transformation with Multiplicative scatter correction (MSC) and second derivative, the spectrum showed 2 peaks at the wavelength of 1432 and 1914 nm. These wavelengths are related to starch physicochemical properties in each variety. Therefore, it can be concluded that the PCA technique alone cannot be used to identify aromatic Thai rice varieties as calibration equations are needed. Nevertheless, the NIR technique can be used to identify aromatic Thai rice varieties when combined with the starch properties of each variety.

Keywords: Identification, rice, near-infrared

Applying MPN (Most Probable Number) Method Combined with PCR (Polymerase Chain Reaction) Procedure for Enumeration of *Clostridium botulinum* Spores in Honey Samples

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Scientific studies have recognised the great medicinal value of honey. However, *Clostridium botulinum* spores have been found in honey that was implicated in infant botulism, a neuroparalytic disease caused by a neurotoxin produced in the infant's intestine after spores of these bacteria are ingested and grow.

The objectives of the present study were to produce spore suspensions of different strains of *C. botulinum*, A, B, C, D, E, and F and to enumerate spores of these strains in spiked honey samples by using an enrichment followed by a PCR procedure, namely MPN-PCR (Most Probable Number - Polymerase Chain Reaction) method, targeting the neurotoxin genes.

Spores of different strains of *C. botulinum* were produced by applying various media. During the anaerobic incubation at 30–35 °C for 4–7 d, the sporulation degree was checked daily with a phase contrast microscope. The cultures that resulted in a very good level of sporulation, more than 60 % of vegetative cells sporulated, were harvested by centrifugation at 500 g, washed 3 times with sterile ice-cold water, and re-suspended in phosphate buffer saline (PBS). The spore suspensions were stored at 4 °C.

Sterilized honey samples were spiked with a known amount of spores of different strains of *C. botulinum*, with each strain separately and a mixture of all the strains. The enumeration of spores was carried out by applying MPN-PCR method. Two media, FAB and CMM, were used as enrichment media. The number of individual strain and mixed strain spores in the spiked samples were similar to the number of spiked spores. The results were similar between the two enrichment media. It can be concluded that the applied method can be used to enumerate *C. botulinum* spores in honey samples despite of the high concentration of sugar in honey.

Keywords: *Clostridium botulinum*, enumeration, honey, infant botulism, MPN-PCR, spores

Using Radio Frequency Heat Treatment to Control Seed-borne *Trichoconis padwickii* in Rice Seed (*Oryza sativa* L.)

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Trichoconis padwickii is the main seed-borne fungus in many of seed crops especially in rice. They can cause the loss in germination, viability, and vigorous of the rice seeds. This study was to determine and evaluate the proper radio-frequency heat treatment on eliminating the seed-borne fungus, not only on the seed surface, but also inside the seed, which affect the seed qualities at the least. The rice seeds cv. “Khoa Dawk Mali 105” (KDML 105) with the initial moisture 10.4 % and viability of 94 % were treated with radio-frequency (27.2 MHz) at the temperature of 70, 75, 80 and 85°C for 180 seconds. Seed health test was assayed by blotter method and the various seed qualities were determined according to ISTA rules (2004). The existing of *Trichoconis padwickii* after treatment was decreased from 29 % from no treatment to 22.2, 17.8, 16, and 11.7 % respectively. Other fungi were found as *Fusarium* sp., *Curvularia lunata*, and *Bipolaris oryzae*. However, among all fungi, *T. padwickii* found to be the main principle seed-borne in rice. The rice seed qualities assessment, the results showed that their qualities were decreased with the increasing of the temperature used. The viability was reduced from 94 % to 39 % at the temperature 85 °C. Therefore, the radio-frequency had significantly showed the efficiency in controlling *T. padwickii* however it reduced the seed qualities. The best temperature used was at 75°C, *T. padwickii* infestation dropped to 18 % whereas the percentage of seed viability was as high as 82 % and the moisture content dropped to 9.3 %. Longer treatment period and other temperatures used should have further research and investigation.

Keywords: Radio frequency, rice, seed-borne, *Trichoconis padwickii*

Influence of Packaging Material and Storage Time on Seed Viability and Chemical Compounds of Rice Seed

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This research aimed to study the effects of packaging materials and storage time on seed viability and chemical compounds changes during storage. Seeds of rice var. Khao Dawk Mali 105 were processed and dried to 9.6 % moisture. Seeds were stored in 4 different kinds of plastic bags i.e. Polyamide (PA), Polyethylene (PE), Metallized Polyethylene Terephthalate (MPET) and Woven Polypropylene (WP) bags for a period of 5 months under controlled temperature (16°C) and relative humidity (65 %) at seed centre No.7, Chiang Mai. The experiments were designed in 4 × 6 factorial RCB consisting of 2 factors; packaging material and storage period. Changes in seed moisture content, standard germination, vigour and chemical composition (crude carbohydrate, protein and fat) were monthly determined. The experiment was conducted from February to July 2004 at the Postharvest Technology Institute and Department of Agronomy, Faculty of Agriculture, Chiang Mai University. The results were: seeds in WP bags had higher moisture content (10.4 %) than seeds in PA (9.8 %), PE (9.8 %) and MPET (9.9 %) bags throughout the storage periods. All treatments showed that rice seeds could maintain their germinability on average 95 % after 5 months. Rice seeds vigour showed by accelerated aging technique and the electrical conductivity from seed exudates was no significantly different after 5 months storage. The analysis of seed chemical composition showed that all the plastic bag types did not significantly affect the carbohydrate (approximately 85.56 %) and protein contents (approximately 7.07 %). However, the fat contents were significantly different. After 5 months, the fat contents in seeds stored in WP bag were lower than MPET, PE and PA bags (1.86, 1.90, 1.97 and 2.01 %) respectively. The fat contents decreased because of the activity of the enzyme lipase in rice seed and the oxygen in the packages which is the main cause of the seed deterioration. It was concluded that rice seeds stored in PA bags which prevented water vapour and oxygen transmission could delay seed quality deterioration followed by PE, MPET, and WP bags. Fat was the only chemical compound which changed during storage. A five month storage period did not showed any influence on the rice seed quality.

Keywords: Packaging material, rice, seed quality, seed storage

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Selected Commercial Packaging Materials Affecting Fatty Acid Deterioration During Soybean Seed Storage

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Soybean seeds var. CM60 from Seed Centre No.7, Chiang Mai have been processed and dried to 10 % moisture content. Seeds were stored in 4 different kinds of plastic bags i.e. Metallized Polyethylene Terephthalate (MPET), Polyamide (PA), Polyethylene (PE) and Woven Polypropylene (WP) for a period of 4 months under controlled temperature (16 °C) and relative humidity (65 %) from January to April 2004. The experimental design was arranged in factorial RCB consisting of 2 factors; storage periods and various packaging materials. The seeds were sampled and assessed at the Chiang Mai University. It was found that seeds stored in WP bags increased their moisture content up to 10.44 % and the free fatty acid was found at the highest number of 1.67 % since this kind of bag is not a water and air proved bag in comparison with MPET, PA and PE bags which the number of free fatty acid were 1.08, 1.17 and 1.53 %, respectively. Increased seed moisture and oxygen in its containers are the main factors in lipid autoxidation which led to the loss of enzymatic activities, failure in protein synthesis and loss of membrane integrity which have shown direct relationship with low seed germination rate and seedling vigour. Comparison with three other packing materials: MPET, PA and PE bags showed better properties in water and air proved (0.09 cc m⁻² h⁻¹ and 63 g m⁻² h⁻¹ for MPET, 0.014 cc m⁻² h⁻¹ and 116 g m⁻² h⁻¹ for PA, and 0.25 cc m⁻² h⁻¹ and 1364 g m⁻² h⁻¹ for PE). Besides that, seed stored in MPET bags could maintain the lowest seed moisture content (9.36 %) whereas in PA it was 9.85 and in PE it was 9.90 % respectively. MPET packaging resulted in the highest number of percentage of seed germination and the most vigorous seeds when compared with the seeds from the other packaging materials. Their storability in MPET, PA and PE bags are over 4 months, whereas in WP bags seeds dropped their viability after being stored for 3 months.

Keywords: Deterioration, fatty acid, packaging material, soybean seed

Laboratory Examination of Biofilms Produced by *Clostridium perfringens* and *C. botulinum*

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Clostridium perfringens and *C. botulinum* cause food poisoning both in human and animal. Botulinum toxin is the most poisonous substance known so far. One gram of evenly dispersed crystalline toxin in the atmosphere would kill more than one million people. They are found in canned and uncanned foods. If *Clostridium* species forms biofilms in nature it may be potential problem to human and animal health but there is no single event reported so far.

Biofilms comprises the “slime” or biological contaminations found on surfaces in contact with flowing fluids, which contain bacteria, fungi, microbial corrosion products and entrapped clay and soil particles. Bacterial biofilms are difficult to detect in routine diagnostics and are inherently tolerant to host defences and antibiotic therapies. They form biofilms on wide range of materials like synthetic polymers, silicon tubes, medical devices, infected tissues.

A special set up was designed and the microscopic slide was placed in glass chamber and connected the set up to the fermentor. After 48 hours slide was removed stained with Alcian blue and counter stained with gram staining. Biofilm like structures were formed by *C. perfringens*. Further experiments were continued with *C. botulinum* which is perceived to be the more dangerous pathogen in the genus *Clostridia*. Glass slides were placed in conical flask and straw in test tubes inoculated with *C. botulinum*. Slides were removed after 15 and 20 hours and straw after over night incubation followed by staining with Alcian blue, Congo red detects biofilm like structures on microscopic slides and straw.

Though above mentioned results are done in laboratory condition and it is not know till now whether *Clostridia* species could form biofilms or not in nature. It could be a potential problem particular in developing countries if these bacteria form biofilms on food as food standard safety levels are low. Further investigation on this aspect could be good to shed the fears of public.

Keywords: Biofilms, *Clostridium botulinum*, *Clostridium perfringens*

Using Radio Frequency Heat Treatment to Control the Insect *Rhyzopertha dominica* (F.) During Storage in Rice Seed (*Oryza sativa* L.)

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Insect pests are response for severe crop losses, its feed directly on rice seed tissue. *Rhyzopertha dominica* (F.) is the seriously stored insect in rice seed. It infested the seeds and damaged the seed at the endosperm and embryo. In addition, the infected seed may loss in their germination and viability heavily and can not consider as the seed. This investigation was established to evaluate the efficiency of radio-frequency heat treatment on eliminating stored insect *Rhyzopertha dominica* (F.) both on the surface, and inside the seeds, which decrease seed qualities at the least. The rice seeds cv. “KDML105” with 10.4 % moisture content and 93 % germination were treated with radio-frequency heat treatment at 27.2 MHz under the temperature of 70, 75, 80 and 85°C for 180 seconds. The result showed that *Rhyzopertha dominica* (F.) were 100 % dead in all treatments. However, the rice seed qualities decreased with the increasing of the temperature used. The seed viability by tetrazolium test was reduced to 91, 82, 64 and 39 % at the treated temperature of 70, 75, 80 and 85°C, respectively. Therefore, the radio frequency heat treatment had significantly a high efficiency in killing *Rhyzopertha dominica* (F.), however it reduced also the seed qualities. The best temperature level was at 70°C with the remain viability still as high as 91 %. Thus, it can be concluded that radio frequency heat treatment has a good potential in controlling storage insect pest which maintain the rice seed qualities. Further study is suggested to investigate and develop more on radio-frequency post-harvest treatment to control insects in rice seed during storage.

Keywords: Insect control, radio-frequency, *Rhyzopertha dominica* (F.), rice

Effect of Storage Temperature on Thermal Properties of Mango cv. Nam Dok Mai Si Thong

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Mango fruit cv. “Nam Dok Mai Si thong” (*Mangifera indica* L.) harvested at fully mature-green stage were stored at 5, 13 and 25 ± 2 °C. The specific heat and thermal conductivity of flesh mango during storage were determined by Differential Scanning Calorimeter (DSC) followed ASTM-E1952 —98 method. The result showed that the specific heat of mango flesh stored at 25 ± 2 °C increased in the first 2 days of storage, and remained constant thereafter, whereas those of the ones stored at 13 °C and 5 °C were relatively constant during 25 days of storage ($p < 0.05$). Thermal conductivity of mango flesh, on the other hand decreased in 5 days when stored at 13 °C, and increased rapidly afterwards. Similar results were found in the fruit stored at 25 ± 2 °C, however, the thermal conductivity of mango flesh stored at 5 °C increased in the first 5 days and remained relatively constant during 25 days of storage. The electrolyte leakage of mango flesh showed similar results with the thermal conductivity for whatever storage temperatures. Chilling injury became visible as pitting and discoloration after 5 and 20 days at 5 °C and 13 °C, respectively. The electrolyte leakage of mango flesh stored at 13 °C increased continuously but that of 5 °C was relatively constant. Since electrolyte leakage is one of the indicators used to determine chilling injury and ripening process, the increasing of electrolyte leakage as well as thermal conductivity in the case of 13 °C might be due to chilling injury incorporated with ripening process. It is possible that the thermal conductivity of the fruit could be related to chilling injury symptom and ripeness.

Keywords: Chilling injury, mango, specific heat, thermal conductivity, thermal properties

Underutilised Crop African Yambean (*Sphenostylis stenocarpa*): Reduction of Antinutrients by Unconventional Processing to Promote Extension

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African yambean (*Sphenostylis stenocarpa*) is a highly drought and pathogen resistant legume producing acceptable yields even under unfavourable conditions. Serious drawbacks are the adverse health effects (**i**) frequently occurring after the consumption of traditionally processed beans in spite of the (**ii**) energy-consuming five hour cooking time. Can alternative processing methods possibly downsize these shortcomings?

The paper reports of two alternative processing methods both based on fermentation. Lactic acid bacteria and the tempeh fungus *Rhizopus oligosporus* were probed. Protein digestibility was as if cooked for 4 h. Undesired compounds, notably oligosaccharides and cyanogenic glycosides, were markedly reduced or absent. Energy use for processing and preparation of meals was down to 20 % of that for traditional cooking. Neither fermentation process requires specific hygienic conditions or any special equipment. The proposed processing methods appear therefore suitable for household and industrial uses.

Keywords: Environment, food processing, legumes, malnutrition, protein

Artisan Oil Extraction Methods for Oleaginous Cultures of the Santarém District, Pará State, Middle Amazon, Brazil

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The western region of the Brazilian federal state of Pará shelters a large amount of unexplored oil crops. Many of them can be used both as vegetable oil source for food production as well as a protein source for live stock feeding or human nutrition. It is expected to use unexplored oil crops as source for Biodiesel production, being part of a programme of the Brazilian Federal Government to increase Biodiesel use in the country. Being part of a larger research project funded by the CNPQ (National Science and Research Council, Brazil) the following work aims to compare oil yield of different traditional oil extraction methods used by local small scale farmers. Oil extraction is done initially from the seeds and fruits of the following surveyed oil crops: Côco-Curuá (*Attalea microcarpa*), babassu (*Attalea speciosa* Mart. ex Spreng.), Pataua (*Oenocarpus bataua* Mart), Buriti (*Mauritia flexuosa* L.) and Andiroba (*Carapa guianensis* Aubl.). Artisan oil extraction methods consist, for Pataua, Buriti and Andiroba in separation of fruit pulp from the seed by cooking or soaking in hot water, extracting the oil mechanically or manually from the pulp material with the aid of manual presses like the “tipiti” in central Amazon. The oil extraction of hard shell nuts like Babassu and Coco-Curuá, is done after breaking-up the nuts, separating the endocarp from the endosperm. Further on the endosperm is toasted in a frying pan, crushed in a pillow and cooked with water until fully evaporation of the water, leaving only the crude oil in the cooking recipient. Preliminary results showed oil concentrations of 30 % (Coco-Curuá), 40 % (Babassu), 45 % (Pataua), 25 % (Andiroba) and 10 % (Buriti). Its expected to obtain oil yield of up to 60 % in Coco-Curuá and Babassu, 70 % in Pataua, 30 % in Andiroba and 25 % in Buriti, by improving the oil extraction methods.

Keywords: *Attalea* spp., Brazil, *Carapa guianensis*, *Mauritia flexuosa*, *Oenocarpus* spp., oil crop seeds, oil extraction, Santarém, tipiti

Documentation of Cavity Closure in Ripening Mango Fruits

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Mango production as a cash crop for fresh fruit and processing markets is increasing worldwide. Mango is a climacteric fruit, so the development stage at harvest is paramount in determining the quality of the final product after post-harvest ripening. The current practical methods for determination of the harvest date are limited, especially in developing countries. In these areas it is mainly done by a manual “tapping” method based on acoustical properties. Mango fruit acoustics change over time because a cavity that initially exists between the mesocarp and the kernel gradually fills as the mango seed develops.

A study on the dynamics of the above mentioned cavity was carried out under the framework of the existing research collaboration between Hohenheim and Chiang Mai Universities on sustainable land use and rural development in mountainous regions of northern Thailand (The Uplands Program, SFB 564). The sample materials were mango fruits of the cultivars Choak Anan and Talap Naa, grown under different irrigation regimes in northern Thailand. Fruits harvested at 24-hour intervals were cut longitudinally through the kernel. A millimetre raster was placed over the cross sections and the area of the seed and cavity for each fruit was measured and recorded by use of digital photography. As a result, the closure of the cavity was documented and correlated with other parameters of mango development which are routinely monitored to determine harvest time.

Knowledge about the ripening behaviour with respect to the closure of the cavity will advance the development of a procedure and/or instrument to automatically detect ripeness of mango fruits, which will be based either on sound detection or ultrasonic reflex.

Keywords: Kernel, ripeness sensor

Development of Appropriate Mechanisms for Cassava Peeling

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Cassava (*Manihot esculenta* Crantz) as a major source of carbohydrate is utilised extensively for human and livestock consumption. Largest quantities of produced cassava are consumed in processed forms, which are labour intensive. Some processes had been mechanised successfully in the production line of cassava products. However, cassava peeling remains a major challenge to food/design engineers involved in cassava processing. These problems stem from the fact that cassava tubers are irregular in shapes, sizes as well as peel thickness. Obviously, variety, cultural and management practices, soil type and soil environmental conditions are part of the reasons for the varied mechanical and rheological properties which are pertinent to cassava peeling automation. Several options are available to the design engineers in the desperate search for appropriate mechanisms for cassava peeling. However, it is important that the problem be considered wholly in order to develop an appropriate machine for cassava peeling. Such machine is basically required in the production line of the following products: cassava grit, gari, cassava flour, cassava chips and pellets, lafun, pupuru, etc. In this study, some mechanisms for cassava peeling are presented. The potentials and limitations of each mechanism were subjected to objective appraisal with the view to determining the most appropriate mechanism for cassava peeling. The peeling mechanisms were eventually developed into a full fledge cassava peeler. The result showed that the optimum peeling device was dependent on some constraints to the objective function. The major constraints include: location, cassava variety adopted for mechanisation and the economic implications of selecting the device for cassava peeling.

Keywords: Cassava grit, food and design engineers, gari, *Manihot esculenta*, peeling mechanism

Single-Layer Drying Behaviour of Longan (*Dimocarpus longan* Lour.)

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Dried longan (*Dimocarpus longan*) is a commodity with increasing volume in Thailand. Since 2004, percentage of dried longan increased from 20 to 40 % of total longan export. Due to rising energy prices production costs are rising. Furthermore, quality is limited by poor drying procedures. Only limited information about optimum drying conditions is available in literature. Objective of this work is to investigate the influence of fruit properties and drying conditions on drying time and quality of longan. In this work, drying behaviour of longan in single layer was observed to eliminate the intrinsic temperature and moisture gradients in multiple layer bulks. Longan was classified in big, medium and small size. Drying air condition was varied in five temperatures from 50 to 90°C, five relative humidities from 8 to 20 % and three air velocities from 0.2 to 0.5 m s⁻¹. The results showed that drying kinetic was strongly effected by temperature and size of the fruits, whilst there was no significant effect of air velocity and relative humidity. Water diffusion process inside longan fruit was modelled by using Fick's law. Based on the single layer model, it will be possible to develop a multi-layer model of the drying processes for simulation, design and optimisation of practice drying operations.

Keywords: Drying, energy saving, modelling, single-layer experiment, value adding

Markets, Standards, Regulations and Policies

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Structure of Rural Financial Institutions Clients in Cameroun

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The original objectives of rural banking sector were:

- to extend credit to small farmers and businessmen especially small female farmers/business women;
- to encourage group lending among borrowers;
- to provide a more efficient institutional capacity for rural credit administration on a self sustaining and permanent basis;
- to provide significant employment opportunities for rural men and women as well as improve nutritional standard of beneficiaries through improved productivity and higher income from the use of credit.

In Cameroon, 51 % of the population is poor and 23 % very poor. 84 % of the poor live in rural areas, while 61 % of the rural population is considered as poor. During two decades after independence, financial repression practised by the government has undermined the evolution of a diversified financial sector with cost-effective services available to all segments of the population. The rural and urban poor have been the most affected. With the liberalisation of the economy in the early 90s, a new consensus on the importance of private rural finance institutions in the development process emerged. This period was characterised by the boom of micro banks all over the country (almost 800 institutions in 2000). However, in the environment in which they are operating, questions on the achievement of their objectives arise. Can they extend their outreach to the poorest while insuring the long-run-sustainability?

The purpose of this research is to find out the segment of the population in which micro banks hired the biggest share of their clients. For this, the Principal Component Analysis (PCA) is used to determine the poverty score of micro banks clients. Information's were collected in 2003 on 264 households' clients and non clients of micro banks. The results shows that just 14.9 % of the clients are from the lowest group (poorest), while 50.8 % from the middle group (less poor), and 34.3 % from the higher group (better off). Government, NGOs and donors then have to play an important role (rural infrastructures, reinforcement of micro banks capacity building) to enable micro banks to achieve their objective of targeting the poorest segment of the population.

Keywords: Clients, financial repression, outreach, principal component analysis (PCA)

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Proposal for Codification of the Phenological Cycle of Edible Musaceae

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The exchange of new findings and joint work on projects presuppose, however, that all those involved have the same understanding of the terms they use. This calls the need for an extensively standardised description of plant development stages in order of their phenological characteristics and their coding.

The phenological development stages of plants are used in agricultural science and practice worldwide, agro-meteorology in the field of phenologic observer and climatic research, each with its own varying individual objectives. This system, called BBCH coding system (BBCH = Biologische Bundesanstalt, Bundessortenamt, Chemical Industry), might help to determine adequate periods for crop and production management in different geographic regions and to collect information during the growth of the plant with the aid of development indicators. So the BBCH coding system is a system for uniform coding of phenologically similar growth stages of all mono- and dicotyledonous plant species. Of particular significance is the fact that the work appears in four languages and thus contributes to a large extent to reducing linguistic communication problems. It thus fulfils in a special way the intertwinement in research, trade, production and service present today. Please find the BBCH coding system with 50 crops and weed species under <http://www.bba.de/veroeff/bbch/bbch.htm>.

The BBCH code proposal for phenological development of Musaceae is presented on the basis of the BBCH-Scale were defined in ten principal growth stages (macro stages). Every principal growth stage was subdivided into secondary growth stages (micro stages) and some was subdivided if necessary into tertiary growth stages (meso stages). If necessary it is possible to use in edible Musaceae four stages.

Keywords: Bananas, BBCH, Growth stages, Musaceae

The Measurement of the Economy of Scale of Microfinance Institutions: A Case of MC2 Cameroon

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This decade saw everywhere in the under developed countries and more particularly in Cameroon the growth of several microfinance institutions having as objectives to mitigate the systems of former rural financing system setting-up by the Development banks, systems which proved to be ineffective. It is known today that the availability of small loan and well adapted services of saving to the populations excluded from the formal financial system constitutes key tools in the process of fight against poverty. According to the study on the decentralised financial system in Cameroon published in 1997, Cameroon counted on this date more than 389 institutions of microfinance. The number evolved in time. The decree MINFIB/MINAGRI No 0015/036 of January 15, 2002 erases more than 388 institutions of microfinance, without counting various voluntary or involuntary closings. It poses consequently a problem of perpetuation and effectiveness of these institution of microfinance in Cameroon.

The study is focused on one institution, La Mutuelle Communautaire de Croissance (MC2), (the MC2 system is an interesting institutional innovation based entirely on the private initiative of Afriland First Bank). The objective is to analyse transaction costs of 10 institutions in the west province who have been operating for at least five years. The transaction costs will be evaluated for a certain period. The study of the evolution of the transaction costs in the functional form double-log (double-log cost function) or Cobb-Douglas (Cobb-Douglas specification) will enable us to determine the capacity of these institution of financial intermediation to generate economies of scale.

The analysis provides the basis for an assessment whether and to what extent the new institutions can be made sustainable rural finance actors

The data were collected in February 2005, the results of the analysis are to be followed.

Keywords: Cameroon, economy of scale, function of production, microfinance, sustainability

The Significance of Food Quality and Safety Standards in Developing Countries - A Case Study for the EurepGAP Standard in the Mango Export Sector in Piura, Peru

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While international agricultural markets experienced an ongoing liberalisation in terms of tariffs and quantitative restrictions within the past years, the significance of sanitary and phytosanitary standards which can act as an impediment to trade is continuously rising. As a part of these standards, food quality and safety standards as required by the private industry are expected, due to the complexity of their requirements, to have an especially severe impact on agricultural export sectors in developing countries.

The paper presents a case study carried out for the mango export sector in Piura, Peru. It investigates the implementation of EurepGAP, a private industry standard for good agricultural practices which is required by a large part of the European market. The research involves quantitative and qualitative socio-economic research, based on the concept of a compliance process in three stages: information stage, decision stage and implementation stage. Information on the standard forms the key condition to make a decision in favour or against the implementation of a standard. At the implementation stage the producer experiences the costs and benefits of the implementation.

The results suggest that a large part of the producers do not dispose of the necessary information and hence do not fulfil the minimum condition to comply with the standard. Evidence is also given on the socio-economic factors that characterise this group and influence in the quality of information a producer has.

The analysis at the decision stage shows that the implementation of the standard is limited to a small group of producers, excluding smallholders, producers with low education and producers with little access to financial resources, among other factors.

The results at the implementation stage show, that the implementation of the standard causes significant costs but also provides a series of benefits for the producer.

In general the picture can be drawn, that private industry standards like EurepGAP can have a serious impact on the sectors, accelerating consolidation tendencies and excluding certain producers which are not able to comply with the standard, due to their specific socio-economic conditions.

Keywords: Developing countries, food quality, EurepGAP, food safety, mangoes, Peru

Rice Market Integration in Myanmar

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Rice production is the most important backbone of the economy of Myanmar as rice is a staple food and major export item. Myanmar agricultural marketing system was controlled by the government under the centrally planned economy lasting about a quarter of century. The major economic changes have significant implications on Myanmar agriculture. The drastic political and economic transition in the later part of 1988 coincide the post-crisis years for agricultural commodity exporters and later with the establishment of World Trade Organisation with Myanmar as the member. The government had introduced the free market economic system and allowed farmers to cultivate crops by their choice and to process, transportation, and marketing and trade almost all the agricultural products with only exception of the rice export. The functioning of rice marketing system is highly related to the national rice policy. Therefore, parallel markets by government intervention and spatial trade can be found in domestic marketing system. The objective of this paper is to appraise the long-term performance of the domestic rice market by evaluating the degree of spatial market integration.

The chosen method is the co-integration; the first step is to test whether the series are stationary by using the Augmented Dickey—Fuller (ADF) method. Then, test for co-integration using the two-step, residual-based test developed by Engle and Granger (1987). Result shows that Myanmar rice markets are integrated under the current political situation. Therefore, rice price in one market is just a translation of the price in the other market, implying that price changes are the same. The presence of co-integration between rice price series is indicative of strong interdependence; its absence indicates market segmentation. However, overall performance of rice market for long run is affected not only by the direct link of marketing system but also the microeconomic policies. It clearly depends on both the macroeconomic environment and the development of infrastructure of Myanmar.

Keywords: Centrally planned economy, co-integration, free market economic system, market segmentation, Myanmar, national rice policy, parallel market, spatial trade, stationary

Debt Position of Developing Countries and New Initiatives for Debt Reduction — Panel Data Fixed Effects Estimation of the HIPC Initiatives

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In September 1996, the World Bank and the International Monetary Fund (IMF) launched the Heavily Indebted Poor Countries Initiative (HIPC). This initiative was endorsed by 180 governments around the world as an effective and welcome approach to help poor, severely indebted countries reduce debt as a part of the overall poverty reduction strategy. Three years later, the initiative was enhanced to provide more debt relief.

This study assesses the achievements of the first and second HIPC initiatives and explores further areas of intervention that might help the HIPCs graduate from debt rescheduling and achieve sustainable growth and poverty alleviation.

Using a panel data fixed effect estimation, we find evidence which suggests that the HIPC debt relief did significantly reduce the debt stock and debt service of HIPCs. The flow effect of debt relief however, is small. It is therefore concluded that debt relief has contributed to increasing poverty-reducing expenditures, but this impact is small. Likewise, the stock effect of debt relief has been diluted by the flows of new loans in HIPCs.

Furthermore, findings suggest that HIPCs have displayed worse governance indicators despite the waves of debt relief. This study emphasises that poor governance, especially high corruption levels, is a binding constraint to achieving both short-term and long-term debt sustainability and higher efficiency gains from debt relief. It is also found that external debt stock and debt service have pernicious effects on economic growth in HIPCs.

Based on the above results and despite moderate achievements of the HIPC measures so far, this paper argues in favour of a HIPC III initiative. Much more relief is needed to link debt relief to poverty alleviation if the expectations raised by the initiatives are to become reality.

In addition, aid and loans are vitally important for the development of HIPCs. A good governance environment is a precondition for increasing the effectiveness of external assistance. Therefore, HIPCs with international assistance must make steady efforts to reverse the patterns of their governance at all levels.

Keywords: Debt relief, governance, HIPC initiatives, panel data, poverty

Quantification of the Economic Impact of EU Aflatoxin Standards on Developing and Transition Countries' Exports Applying Gravity Model

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Globalisation raised the importance of food safety and quality concerns. Developed countries implement precautionary food regulation policies to protect their affluent consumers from unsafe food imported from developing and transition countries. The countries are strongly encouraged by the World Trade Organisation (WTO) to adopt internationally recommended standards, but they are also allowed to implement policies, setting even stricter standards.

The alarming number of trade disputes at WTO however evidences cases of abuse of such policies. The fear is that the dwindled traditional trade barriers could be substituted and even surpassed by Food Regulatory Measures (FRM). While claims on protectionist nature of FRM are valid in principle, there is little empirical evidence about their economic effects. The question of quantification of trade impact of FRM is absolutely essential for the new trade agenda. This problem is on focus of trade policy debate for developing countries, yet it is not considered seriously for transition countries. Such a research for these recently liberalised markets gains a special significance due to their active participation in world trade. Their exports to developed countries include cereals, fruits and vegetables, which are especially exposed to natural toxin (e.g. aflatoxin) hazards and often face stringent food standards.

This research aims at understanding the role of developed countries' aflatoxin standards in dynamics of exports from developing and transition countries, by assessing the trade patterns and quantifying the effects on trade between 13 importing (developed) countries and 25 exporting (developing and transition) countries. The study adopts the principles of the Gravity Equation Model. The results of cross-country analysis prove the hypothesis that the stringency level of food regulations on aflatoxin is negatively associated with trade flows from developing and transition countries.

Particularly, our findings evidence that adopting a worldwide standard for aflatoxin B1 based on current international guidelines could increase the cereal and nut trade among model countries by about \$US 6,5 billion compared to 1998 levels.

The results of the research will assist international policy makers in designing new global trade agenda.

Keywords: Food chain, food safety and quality

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Food Safety and Development: How Effective Are Regulations?

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Rising income levels, changing consumption patterns and food scares have induced the development of tightened food quality regulations not only in developed countries. In Viet Nam, the growing importance of trade in food and high incidences of food poisoning and environmental pollution have raised the attention of consumers, producers and politicians. Particularly vegetables contain a host of contaminants at levels well above maximum residue limits, including pesticides, nitrate and heavy metals. In response to this problem, the Vietnamese government has launched a 'safe vegetables' programme in 1995 that has segmented the vegetable market into 'safe' and 'conventional' products.

The objective of this paper is to examine the effectiveness of food safety regulations in Viet Nam. By analysing strengths and weaknesses at different levels of the supply chain, we develop recommendations on how to improve the Vietnamese food safety system. Major questions for each level of the 'safe food' and 'conventional food' supply chain include (a) whether and to which extent current regulations are an effective tool to achieve food safety (b) which role do supply and demand play in this process (c) how food safety regulations and control systems could be improved and targeted to enhance food safety.

Methodologically, we use a comparative supply chain approach. The empirical case studies focus on different cabbage supply chains in Viet Nam. The comparative nature of the approach allows for the identification of key characteristics and problems in supply-chains of 'safe food' and 'conventional food' products.

Preliminary results confirm consumers' concern about food safety and willingness to pay price premiums for guaranteed food safety. Limiting factors do exist on the supply rather than on the demand side. The lack of producers' knowledge on adequate production methods and the absence of an effective control system are major obstacles on the way to more food safety in Viet Nam. Further results should encourage a better training of farmers on integrated-pest-management practices and a grading-up of control systems. This would protect consumers from food safety threats and benefit producers by increasing consumers' trust in their produce and thereby improving their long-term marketing prospects.

Keywords: Food legislation, food safety, supply chain, Viet Nam

Political Regulation of Soil Protection in China and India

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China and India both have long traditions in soil conservation. These efforts have increased recently in the course of a rising awareness for environmental concerns.

This paper analyses the state and development of national political regulation of soil conservation in China and India. The analysis is based on a review of primary documents, literature and web-based information. The comparative perspective on China and India yields insights into important political factors of environmental policy.

The work is guided by an approach to environmental policy analysis focusing on the following determinants of environmental policy: the structure of the environmental problem, actors and their strategies, structural context factors (political, institutional and economic conditions) and situational factors (e.g. natural disasters). In the case of developing countries, international influences from development aid or international conventions are rather strong. Therefore, this work extends the framework to incorporate these influences.

The paper first presents the developments of soil conservation policies and legislation in an international perspective highlighting the general difficulties in regulating this particular environmental problem. International activities are rather weak compared to other environmental topics, but can nonetheless be seen as incentives to increase national conservation efforts.

China's political efforts in soil conservation range back to the first half of the last century. Throughout the decades, afforestation was a major means of soil conservation in China. In recent times, environmental policies have benefited from a high priority in the national administration. An increasing attention to natural resources only occurred in the last years. This can be seen in parts influenced by international activities, among them the United Nation Convention to Combat Desertification (UNCCD), but also an increased concern following the Yangtze flood in the late 1990s. Implementation proves difficult, especially at the community level.

In India, introduction of a soil protection legislation is hindered by the federal system, in which the states are responsible for land. Environmental movements, focusing strongly on livelihood-issues like the protection of forests for indigeneous use, played a strong role in placing natural resource management on the political agenda. Measures for soil protection are strongly characterised by participative and integrated approaches.

Keywords: China, India, policy analysis, soil protection policy

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The Impacts of Fair Trade

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The decline of commodity prices has had a dramatic impact on the lives of millions of small-scale producers in developing countries. The paradox is that while the food chain as a whole is profitable, the gap between the price producers receive and retail prices has grown. Fair Trade (FT) seeks to address this problem by directly linking producers with consumers. While the FT movement has grown substantially, limited work has been done to study the effectiveness of the scheme. This literature review found the impacts of FT on different stakeholders to be varied. While impacts are tangible and generally favourable at the producer and producer organisation level, they are more difficult to discern for other stakeholders (i.e. business, governments, EU, WTO).

The livelihoods approach was applied to analyse the impact of FT on small-scale producers and their families, as well as the spill over effects of FT on the community. Producers have experienced decreased financial vulnerability and gained a sense of empowerment. Producer organisations, while possibly becoming dependent on FT, have benefited from institutional capacity building, increased inflow of funds and gained access to global markets. Businesses themselves have realised greater financial opportunities, altered their marketing approaches, and shifted their focus to being more responsible corporate citizens. However, as mainstream businesses adopt this approach, the FT movement's focus on improving producer livelihoods is at a risk of being diluted. The impact of FT is further evaluated on three different political entities: national governments, the European Union, and the World Trade Organisation. At the government and international organisational level, FT advocacy achieved greater recognition and financial support. However, changes in trade policies have not been witnessed. A major challenge to the movement is the difficulty in assessing impact. While this report discussed various methodologies for the assessment of impacts of FT, no approach specific to FT was identified, despite attempts to modify existing methodologies. Thus, impact assessment remains limited, and focuses mainly on the impacts on producers. The predominance of positive benefits highlights the potential of FT as a tool for significant poverty reduction, if applied on a wider scale.

Keywords: Business, capacity building, fair trade, impact assessment, producer organisations, small-scale producers, value chain

Development of an Economic Model for Agricultural Policy Evaluation in China

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China has become a member of the WTO since December 2001. China's accession to the WTO is likely to create the most important change in the country's policy environment for agriculture, both domestic and trade policies. What are the possible impacts arising from China's agricultural policy changes on agricultural production, consumption, and market prices? Will the farmers in different provinces be equally affected? The objective of this study is to answer such types of questions by establishing a Chinese agricultural sector model and applying it to the analysis of the impacts of agricultural policy changes. The model will help the policy makers (i) make projections of the future frame condition, (ii) evaluate the applied policy and (iii) make agricultural policy simulation.

The model is a spatial equilibrium model with 30 regions and 13 crops. The supply system is estimated and calibrated with the generalised maximum entropy method as an alternative to the traditional Positive Mathematical Programming method. Demand parameters are based on other studies from the literature. Foreign trade is modelled with the Armington method. Commodity balance in each region is maintained by a balance equation. A price relation equation ensures that price differentials do not exceed the transportation cost and market margins between the regions. The total model has 11 block equations, 13419 single equations and 13419 variables. The model is written in the General Algebraic Modelling System (GAMS) and solved by the mixed complementarity programming (MCP) solver. Projection to 2010 is made and different trade and domestic policy scenarios are simulated based on the model.

Keywords: Agricultural sector model, maximum entropy, mixed complementarity programming, spatial equilibrium

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Food Security and Marketing Problems in Nigeria: The Case of Maize Marketing in Kwara State

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This paper examines problems of food marketing and security in Nigeria, using maize marketing in Kwara State as a case study. This is against the background of persistent food crisis being experienced for sometimes now in the country. Primary data were collected during the 1997/98 farming season from two hundred food marketers consisting of eighty wholesalers and one hundred and twenty retailers spread across six local government areas of the state. Secondary data were collected from Central Bank of Nigeria statistical bulletin and annual reports. The data collected were analysed using descriptive and inferential statistics. Market margin, distribution of total market margin and marketing efficiency were estimated. The results indicate that the average farm gate price of maize was N 755 per 50 kg bag of maize. The average marketing cost was N 105.3/bag and the average net marketing margin was N 158.2/bag. The average marketing efficiency was 143.5 % in the study area. The distribution of total marketing margin shows that the wholesalers' share was 68.1 % and the retailers' share was 31.9 % on the average. When compared with the farmers' returns, the middlemen's share of total market margin was higher. This is perceived as market exploitation because not much values are added to the food by the middlemen to justify the very high margin collected. This "exploitation" directly or indirectly lead to loss of interest in farming and subsequently food insecurity in the country. Responses of the selected respondents show that the major problems of food marketing are; transportation problem, inadequate market infrastructure, inadequate funding, shortage of processing facilities and seasonality and perishability of food produce. To improve food marketing and food security situation in Nigeria, it is recommended that adequate transportation facilities, in terms of good roads and functional vehicles should be provided by government, private individuals and cooperative groups. Also, research into post-harvest storage and processing techniques should be intensified and finally, fund should be made available, through both formal and informal sources, to food marketers so that they can take advantage of bulk purchasing, market expansion and post-harvest processing.

Keywords: Food marketing, food security, market efficiency, market margin

How Can Microfinance Contribute to the Promotion of Agricultural Value Chains? Experiences of a GTZ Programme in Burkina Faso

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From the 80s to the late 90s unnumeral development projects surfaced in microfinance to facilitate access to credit. The idea was to either help finance capital formation and agricultural inputs or carry out new income generating activities.

Regrettably, most of these projects failed as the approach adopted was neither viable nor sustainable.

Learning lessons from these experiences, the GTZ's Agricultural Development Programme (PDA), intervening in the East and South East of Burkina Faso and working towards the promotion of agricultural value chains, has come up with a new approach to increase farmers' income.

This approach consists in establishing sustainable links between farmers and microfinance institutions (MFIs) and concerns actually four profitable commodities: banana, beekeeping, poultry farming, and cattle fattening. Protocols specific to each of the four product chains have been developed between the Programme and the MFI. The major role of the programme is to provide, through limited intervention, the technical assistance needed for the activities to be successful. Overall, the Programme covers 30 % of the risks, as opposed to 70 % for the MFI which funds farmers from its own resources. In the coming three years, the risks borne by the Programme will be progressively reduced to zero (0).

This partnership made it possible to implement, for the first time ever in the sub region, a leasing credit with an MFI (motor-pump for banana production).

To guarantee the security of the lands to be farmed and the credits, local arrangements have been made between landlords, farmers, and local authorities. Similarly, local communities have organised themselves building on their social capital and using peer pressure for credit payment.

It is hoped that this experience, after a couple of years, leads to increased collaboration between farmers and MFIs as a result of a better knowledge of risks associated with agricultural activities and the PDA's phasing out from the system

Keywords: Burkina Faso, case study, local arrangements, microfinance, PDA, protocols

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Business Planning to Establish Small and Medium Sized Processing Units in Sub-Saharan Africa: Experiences from Case Studies in Rwanda and Tanzania

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Small and medium scale processing enterprises in the Sub-Saharan African agricultural sector serve various purposes: Adding value to raw products and thus increasing small farmers' income, entering alternative markets for food and agri-industrial products, providing off farm income in rural areas, and capacity building for processing activities on global markets.

Business planning requires assessment of the technical and financial issues of the processing plant, but also of output markets, the related raw material supply and factor markets, and of different financing options.

Output markets doubtlessly play an important role in the business planning. Here, it is important to assess the size of the expected market both presently and in the future, and to separate market segments according to products and buyers. Apart from ordinary markets, institutional markets like food relief programs or the public sector are gaining importance in Sub-Saharan Africa. These markets have to be specifically targeted and the enterprise designed accordingly. Market size, as well as its development over time, sets the parameters for the enterprise's capacity's requirements and utilisation and also determines its financial viability.

For the raw material supply there are various options like markets, outgrowers' schemes, farmers associations etc, with different related transaction costs, as raw material supply is subject to seasonality, risk, and opportunities for other cropping activities. The same holds for factor supply, in particular labour, which is subject to constraints from many other socio-economic activities in rural areas.

Finance options are evaluated for profitability and risk, looking at different credit conditions offered by public and private banks, concerning — apart from interest rates — annuities, flexibility of paybacks, and collaterals. Short payback periods and early break-evens are crucial because such agro-enterprises operate in a risky agricultural environment, where time plays a more important role than in developed economies.

The study exemplifies the above mentioned issues by quantitative and qualitative information from two business planning exercises, one of them a soybean processing plant in Rwanda, the other a cassava processing plant in Tanzania.

Keywords: Agro-enterprise development, business planning, Rwanda, Tanzania

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Contribution of Livestock to Household Income and Food Security — Comparison of Smallholder Systems of Different Production Intensity in North Viet Nam

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In mountainous areas of Viet Nam, livestock is an important component of integrated smallholder agricultural systems. Livestock contributes to cash income, consumption, has religious, socio-cultural, and cropping-related functions (manure, draught).

This contribution aims to evaluate the relative importance of livestock in general and of different species in particular for cash income and food safety of smallholder households in the mountainous areas of NW Viet Nam. Fieldwork was conducted from 1/2002 to 8/2002 in four villages of ethnic Black Thai, and from 3/2004 to 5/2004 in three H'mong villages, Son La province. Villages cover a gradient from valleys near town with improved infrastructure and market access (2 Thai villages) via upland areas further away from town (2 Thai villages) to remote hillsides with less developed infrastructure and restricted market access (3 H'mong villages). Structured household interviews focused at socio-economic conditions, output from animal production, and consumption of animal products, in a total of 109 households (HH).

Total yearly output from livestock in monetary terms (sale, consumption) was 6.8 and 11.4 million Viet Nam Dong (VND) per HH (near town), 7.5 and 4.5 million VND/HH (intermediate location), and 1.9 to 2.3 million VND/HH (H'mong villages).

Pigs yielded a cash revenue in 90 % of Thai households, fish and chicken only in Thai households near town. The annual revenue from pigs was highest. In H'mong villages, 20 % of households sold pigs, 29 % sold chicken and 8 % sold ruminants; ruminants and pigs yielded the highest revenue. Total yearly revenue from livestock was 5.2 to 8.2 million VND/HH (near town), 1.4 to 1.6 million VND/HH (intermediate location), and 1.0 to 2.0 million VND/HH (H'mong villages).

Main species consumed were pig, fish and chicken. Monthly consumption of farm-raised animal products in H'mong villages was considerably lower (pork 0.1 kg/capita, chicken 0.04 kg/capita, fish 0.05 kg/capita) than in Thai villages (pork 0.9 kg/capita, chicken 0.6 to 0.9 kg/capita, fish 1.3 kg/capita). In Thai villages, frequent market purchase contributed additionally to animal product consumption.

Results show that output, cash revenue and food supply from livestock production decrease with increasing remoteness and altitude. Farmers production objectives, and the meaning of livestock for daily consumption, nutrient supply, and consumption in the frame of religious/ritual ceremonies are discussed.

Keywords: Food security, household income, smallholder livestock production, Viet Nam

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Impact of Selected Influencing Factors on Market Supply of Sheep in Sudan: Case Study of Kordofan Areas

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Most of the Sudan's livestock wealth is in hands of traditional producers. Despite the fact that traditional production methods have great advantages of utilizing marginal lands (natural pasture of organic origin) it puts Sudan's market supply of sheep under the mercy of producers' attitudes and believes. Based on primary data, this study was carried out to analyze the impact of selected influencing factors natural resources (rainfall and natural pasture), animal density, availability of water, and improvements of production inputs (veterinary services and purchased animal feed) on market supply of sheep in Sudan. Accidental sampling technique was carried out, whereby 115 respondents were interviewed in August 2002. Gibiesh market in western Sudan (Kordofan State) as a major market for desert sheep (hamari) was selected for the study. Mean comparison analysis was used to arrive at the stated objectives.

The result revealed that farmers prefer to supply more of their sheep during conditions of heavy and poor rainfall (rich and poor pasture), but they adopt a policy of over-stocking under moderate rainfall conditions. It was also evident that producers prefer to sell more of their young animals (younger than 12 months) when the animal density is high. With expectation of low animal density, they sell more of the old ones. They as well sell more of their animals during adverse conditions of poor drinking water availability, refraining from sales when water is abundant.

Based on farmers' past ten years experience, any improvements in animal feed induce producers to sell more of their male sheep. In contrast, market supply of female sheep increases during periods of moderate and increasing levels of animal feed availability. Also it is apparent that, improving levels of veterinary services encourages producers to increase their supply of both male and female sheep older than 12 months. On the other hand, they are compelled to sell more of their younger sheep (younger than 12 months) under deteriorating access to veterinary medicines. Conducive policy intervention to stabilize sheep supply includes stable pasture and drinking water availability as well as tax exemption and subsidized veterinary services on progressive male sheep sales.

Keywords: Animal density, animal inputs, market supply, natural pasture, rainfall, veterinary care, water availability, policy measures, over-stocking

Measures and Determinants of Export Success in Agri-Businesses: A Firm-Level Analysis of Small and Medium-Sized Enterprises in Honduras

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For developing countries, reaching international markets is a great challenge. There are examples of enterprises that have been able to successfully participate in international markets, but do we really understand what it takes for a small enterprise to survive in a global economy? How can they secure a position in the market in relation to the international best performers?

The agro-industrial sector in northern Honduras presents an opportunity to examine the factors that determine the success of export-oriented small and medium-sized enterprises (SMEs). Although many have inserted themselves in the international market, it is still unclear which factors determine their success while exporting.

Based on the empirical investigation of 64 agro-industrial SMEs we observed that the management capability is a key factor for the successful integration in global value chains. Variables such as the education level and international experiences of the management team, firm age and size, as well as level of technology and strategic planning and were examined. In particular those businesses that have internationally experienced managers (i.e. education abroad) and a food safety or environment certification, show a higher export intensity. Other factors such as firm age, size, or age of technical equipment do not appear to be critical determinants for the success of an export enterprise. These results indicate that in industries such as food processing, which are characterised by a high degree of international competition, the international experience of the management team has a more significant effect on the export success than the technological level of the firm.

Keywords: Export success, food value chain, small and medium-sized enterprises

Response of Plant Productivity to Improved Agricultural Markets in India: An Advanced Application of Econometric Cross-Section Time Series Analysis

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Many decades of research in agricultural productivity witness mostly efforts to show the usefulness of the application of more and better inputs (e.g. fertiliser) and other important production factors (e.g. credit). Recent studies, in addition, pay increasingly more attention to the role of agricultural markets in achieving better productivity. These studies show significant relationships of productivity increasing with better market access however using only cross-sectional data thus not considering the dynamic effects and possible causalities. Our study investigates the impact of market access proxy variables on the aggregated plant productivity using a cross-section time-series dataset on 235 districts in India over a time period of 29 years.

In the article we present the case of South India comparing the newest findings with the previously published results. This article is a follow up of the earlier publications on the ongoing research, which, using more advanced methods of econometric analysis, attempts to prove the main hypothesis that better market access leads to improved productivity. In this contribution, we go beyond modelling for fixed- and random-effects (widely used models for panel data analysis), and we apply more sophisticated Generalised Least Squares (GLS) models which count for heteroskedasticity and serial correlation in panels (tested using Wooldridge test and likelihood-ratio test respectively). Our main variables of interest, road and market densities, are highly significant (and with the signs in expected direction) resulted from markedly improved model specifications confirming that we, in general, stay in accordance with our previous findings. New parameters demonstrate much less standard errors in addition to greater coefficients indicating towards considerable efficiency gains and more consistent results (also, 95 % confidence intervals are much narrower). The lag with which productivity responds to market access is around three years. Increase of 10 % in road density results directly in 2.3 % increase in productivity. A 10%-increase in the number of regulated markets in a given area would bring about 1 % productivity gain. The study also shows that other economic and socio-demographic variables, among others agricultural loans, literacy level, irrigated area, fertiliser application contribute immensely to increasing productivity.

Keywords: Direct effects, generalised least squares, market access, panel data, productivity

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Small Scale Industrial Cash Crop Production and its Impact on Food Production and Living Standards: A Case of Kenyan Tea and Coffee Sector

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This paper is based on an ongoing research on impact of cash crops on living standards under different farm and family conditions. Kenya relies on production of coffee and tea among other industrial cash crops to earn foreign exchange. The rural small scale coffee and tea farmers in Murang'a District do not understand much about foreign exchange but toil in their land every day, month, and year to earn some income from these crops.

For many years, coffee farmers have earned handsomely from their farms. However, in the late 1980's, due to decline in coffee prices, competition in the world and wrangles in coffee co-operative societies among other factors, coffee farmers have found themselves in a very poor state financially and emotionally. In tea farming, the conditions in the market have also changed. Increased competition in the tea industry, high demands for high quality tea and as farmers claim, too many channels in tea marketing have drastically reduced their income.

Due to early year's attractive income from the two crops, most farmers left little land for food production. The tea farmers spend all their time in their farms since tea grows through out the year. Production cost is therefore very high and with small farm sizes, both crops are not paying back. The farmers are now faced with double problem - low income from cash crops and no food from their farms.

The paper aims at assessing the impact of different farming practices and economic diversification on living standards. The paper will discuss to what extent the farmers have diversified and strategies which they have adapted to improve their living standards. The paper is motivated by the fact that despite low income from coffee and tea and little external assistance, the farmers have identified survival strategies to raise their living standards from total poverty.

Keywords: Decline in cash crops income, diversification, food production, Kenya, living standards

The Influence of Market Access on Land Use Patterns of Rural Households in Central Sulawesi, Indonesia

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Farmers living in remote areas of developing countries often lack adequate access to agricultural input and output markets, which is particularly restricted during rainy seasons when tracks and roads are impassable. Due to changing price relations at the farm gate level and high transaction costs, market access influences land use decisions. This is the case for many villages near “Lore Lindu National Park” (LLNP). We will empirically test these relationships in the vicinity of the national park, which is characterised by the conversion of tropical rainforests into agricultural land, particularly for the cultivation of cocoa.

Based on the above problem, this paper will particularly address the following questions: **(1)** describe and classify households’ access to markets **(2)** explore the relationship between households’ access to market and land use **(3)** analyse the influence of market access on land use using an econometric model. Data was collected in 2004 through standardised formal questionnaires from 265 randomly selected households out of 12 villages around the LLNP.

The research area is characterised by strong differences in access to market. While 66 % of the households need less than ten minutes to reach market, 12 % of households live more than an hour away from the closest market. During the rainy season, only 13 % of the households need longer to get to the market compared to the dry season. The main crops grown are paddy rice, cocoa and coffee. The influence of market access on the cultivation of these three crops will be analysed using econometric modelling.

Keywords: Econometric modelling , Indonesia, land use, market access

Better Integration of Small Farmers into Trade — The Case of the Chilli Pepper Value Chains in Ghana

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In the last decades the importance of global trade for economic growth has been increasing and the integration of the poor population in developing countries into world trade is seen as one strategy of successful poverty reduction. With regard to a better integration of small farmers into world trade the value chain approach has gained growing importance in developing cooperation during the last years.

Value chain analysis considers not only the efficiency of production but also any other factors which determine the participation of small farmers in final markets. The challenge for development cooperation is to promote those possibilities of integration that allow for sustained income growth of small producers, e.g. through processing or other value adding activities rather than supplying raw materials only. However, it has to be kept in mind that small farmers are confronted with different kinds of requirements regarding quality, price, delivery reliability and compliance with standards; requirements which generally increase with a higher integration into markets.

An ongoing field survey in Ghana analyses constraints and potentials in two different value chains for chilli pepper, with one chain serving export markets and the other one concentrating on domestic markets. The question is which one offers better opportunities for small farmers, or if both or none offer noteworthy chances.

The analysis of the two chains will focus on their general structure, the different participants at the single stages in the chains and their share in adding value. The distribution of incomes and benefits in the chains will be identified and their respective constraints and possibilities will be compared. Through the detailed analysis of strengths and weaknesses, opportunities and threats arising from the integration in the different chains possible impacts can be identified and the importance of value chain integration for small farmers can be appraised. This will allow conclusions about targeted interventions of development cooperation which can improve small farmers' livelihood.

Keywords: Chilli pepper, development cooperation, Ghana, impact assessment, integration into trade, small farmers, value chains

The Sectoral Project “Agricultural Trade” of GTZ: Pilot Cooperation with Projects / Programmes that Promote Value Chains

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The value chain approach, a growing topic of debate in development research and development policy in recent years, looks at the issue of how production and trade chains are structured and how they can be regulated and managed. In German international cooperation, too, there are various projects at the planning or implementation stage that make specific reference to the value chain concept or to similar approaches (clusters, business linkages). However, an overall conceptual platform and intervention practices systematically based on this kind of platform are lacking. Preliminary conceptual work also needs to be carried out in order to integrate the approach into development-policy strategies such as poverty reduction and trade liberalisation.

The sectoral project “Agricultural Trade” of GTZ analyses experience with the promotion of value chains, and gives specific recommendations on how to integrate the concept into trade projects and development strategies. The purpose is to provide the German Federal Ministry for Economic Cooperation and Development (BMZ) and implementing organisations with some guidance in the design of projects.

Pilot cooperation with selected projects/programmes that promote value chains in Africa, Latin America and Asia will be presented.

Keywords: Africa, agricultural trade, Asia, developing countries, Latin America, pilot projects, value chains

Being Member or Non Member in an Agricultural Cooperative in Kazakhstan — A Case Study of Two Farm Families

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Until today there is a lot of discussion whether it is advantageous to stay in big units to crop the land or to have individual farms in Kyrgyz Republic. After the collapse of the Soviet Union the Kyrgyz Republic became independent and started with the reform of the economy. In the agricultural sector the big Kolkhozes and Sovhozes which had an average of 3,000–4,000 ha were privatized and divided among the members. The members could decide whether to divide the property or to go on by a common cultivation of the land. In the second case they chose the juridical form of Joint Farm of Joint Stock Farm.

Up to now the information available about the farm families situation in the area is very limited. The present paper analyses in a first case study the situation of two comparable families where one is member in a cooperative and the other is an individual family farm. The data were collected using intensive interviews in Kotormo village in the South West region. Additionally comprehensive socio-economic data of TES Centre in Osh oblast of 2004 could be used for the analyses. A focus is given to family income and decision making.

The analyses showed that the family working in the cooperative could achieve a higher income per man hour as well as per hectare compared to the individual family farm. This was due to several factors such as off-farm income and production intensity. But the most important factor were the better market relations and higher prices which the cooperative could obtain.

Keywords: Agricultural cooperative, farm family, Kazakhstan

Livelihood, Risk and Vulnerability

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Evaluating Agricultural Systems Based on Mulch Technology: A Case Study

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In this paper we evaluate the effects of introducing mulch technology, a mechanised chopping of the fallow vegetation, in farm family units of the eastern Amazon region of Brazil. The proposed approach includes social research, field experiments and a thematic model to calculate economic performance indicators and technical efficiency scores. These were determined using Data Envelopment Analysis (DEA) models in order to compare agricultural systems applying mulch technology to those using slash-and-burn agriculture. DEA is an optimisation method that generalises single-input/single-output technical efficiency measure to the multiple-input/multiple-output case by constructing a relative efficiency score as the ratio of a single virtual output to a single virtual input. It is a methodology directed to frontiers: instead of trying to fit a regression plane through the centre of the data as in statistical regression, for example, one 'floats' a piecewise linear surface to rest on top of the observations. The results indicate that systems with temporary cultures (e.g. beans, maize and cassava) using slash-and-burn technology were more efficient with a better economic performance. On the other hand, agricultural systems with permanent cultures (e.g. passion-fruit) using mulch technology had higher efficient scores, but lower economic performance when compared to those that used slash-and-burn technology. We conclude that the economic viability of mulch technology demands the reduction of the hour/machine cost, as well as the increase of the family monetary benefit, by intensifying land use with vegetables such as maxixe, sweet pepper and egg plant in the temporary production systems. The aggregated value of the production systems based on this technology can be also reached by the inclusion of organic agricultural techniques and the obtaining of a certification for this ecological process.

Keywords: Economic performance indicators, mulch technology, rural family labour, slash-and-burn agriculture, technical efficiency

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Farm Assurance — Friend or Foe of Small Scale Farmers in Developing Countries?

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European consumers are increasingly paying attention to food safety especially if raw materials or fresh produce are originating from developing countries. Laws have become stricter, as governments and supermarkets have responded to food scandals and growing consumer concerns. Food quality controls on European and imported produce include legal limits on the maximum pesticide residue level permitted in fresh produce, as well as on independent quality criteria of retailers like ecological and social production standards or traceability of goods from individual farms to supermarkets — complex catalogues of requirements farmers have to comply with in so called „farm assurance“ processes.

Farm assurance provides controlled and more efficient production of agricultural raw materials. It is thought as a farmers' response to globalisation. With respect to the European consumer it reassures and improves confidence in agricultural products. But what does it mean for small scale farmers of developing countries? Are they able to avoid to be excluded from the export market?

In 2002, we assessed the Ghanaian pineapple production sector before the introduction of retailer certification programmes (especially EurepGAP - Euro-retailer produce working group - Good Agricultural Practices) in order to forecast the after-effects of such farm assurance systems on small scale farmers. Recently, we are evaluating what happened since 2003. We shall report how conflicts between food safety requirements, sharp supermarket purchasing practices and the position of small and medium-scale farmers is managed in the pineapple export sector of Ghanaian economy. The results show that on one hand the challenge to comply with the criteria led to improved educational and infrastructural conditions but on the other hand created enormous financial problems for small scale farmers. The most effective action to prevent exclusion of the world market was the integration of small scale farmers to cooperatives which increased in two years three-fold. Valuable certification systems allow joined certifications of such cooperatives.

Keywords: Certification, consumer protection, ethical trade, farm assurance, Ghana, pineapple

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The Socio-Economic Impacts of Soil Quality Improvement by Adopting Soil Conservation Strategy among Small Scale Farmers in Uganda

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In Uganda like in many other countries, land degradation is caused by both natural forces and human action but can only be remedied through proper human intervention. Soil and water conservation practices offer possibilities of reversing soil degradation. Successful conservation depends on understanding farmers' needs and perception of the problem. Most farmers require improved living standards and stable production. The objective of this article was to assess the long-term impacts of adopting soil conservation strategies on living standards of families in two zones in Uganda. This was achieved by modelling the empirical data from two study sites in Uganda experiencing degradation problems. The evaluation of questionnaires distributed to 100 families between April and August 2003 in a survey generated this data. Through mathematical programming techniques the family decision process under the changed scenarios due to conservation strategy implementation was evaluated. Results indicated that changing the land quality through earth bund construction had positive impacts on family economics. Family income in intensive zones will increase from 3,713,000 shs currently to 7,401,00 shs in ten years representing a 109% increment. In the low conservation zone the incomes would increase from 1,825,000 to 3,247,000 shs representing a 96 % increment, and leading to a higher living standard. If current soil degradation continues unabated, the income will decline with consequent deterioration of the family living standard. In intensive zones family income will decrease from 3,713,000 to 3,542,00 shs whereas in the low conservation zone the incomes would fall from 1,825,000 to 1,652, 000 shs. Data of unused family labour show that a conservation strategy would reduce unused labour from 45% to 10% in the intensive zone and from 40% to 33% in the low conservation zone. In both zones an implementation of conservation strategies will reduce the amount of land allocated to crop enterprises by 10% but will not alter the number of cattle kept. If more land was freed for family use leading to a reduced need to open up new areas for farming activities thus reinforcing land resource use sustainability.

Keywords: socio-economic, soil conservation strategy and living standard, soil quality

Livelihood Strategies of Vulnerable Households under Resource Scarcity — Insights from Northern Viet Nam

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Poor and vulnerable rural households in the mountainous regions of Northern Viet Nam are exposed to various risks, crises and shocks, which threaten their livelihoods and have long-term effects on risk management strategies. Following the Sustainable Livelihood Framework of the British Department for International Development, people have access to five forms of capital, i.e. social, financial, human, physical and natural assets. Being one form of natural asset, grazing land is considered a common-pool resource in the agricultural systems of ethnic minorities in Northern Viet Nam.

This paper intends to explain the interaction between grazing land and livelihood strategies, and searches for the reasons and consequences of the recent dynamics of this interaction. Quantitative and qualitative research, including individual as well as group interviews and participant observation, were carried out in 14 villages, with 300 respondent farm-households in mountainous Northern Viet Nam.

During the last 20 years, the population of Son La province has doubled. At the same time, agricultural production was significantly intensified and tenure policies with a strong focus on individualisation of resource rights were gradually implemented. As a consequence, grazing areas were diminished or even disappeared, limiting the opportunity for livestock production. Raising livestock and selling it in case of a livelihood emergency is one of the most popular risk management strategies of the Vietnamese rural poor. Formal insurance schemes or other organised security networks do not yet exist, and people still have to rely on traditional coping strategies. Although providing protection in the short run, these strategies often limit the poor people's long-term prospects of escaping poverty.

Results suggest that due to insufficient land availability and tenure individualisation, farmers were forced to reduce their livestock and thus limit their livelihood strategies. Suggestions are given to counteract the gradual trend of the already existing downward spiral of livestock production. To assure sustainable development for ethnic minority farmers, a bundle of alternative strategies has to be initiated. Different actors will have to focus on locally specific strategies, the basis of these being the possibility to access the different forms of capital assets outlined in the Sustainable Livelihoods Framework.

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Keywords: Grazing land, livelihood strategies, natural resource management, Viet Nam

Principal Component Analysis of Poverty in Northern Thailand

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The North of Thailand is among the poorest regions of the country. To a large extent the population belongs to ethnic minorities with few income sources. For this reason, this paper examines the status of rural household poverty in northern Thailand and identifies the relevant determinants.

Data were collected in nine villages in Mae Rim district, Chiang Mai province. Two groups of farm households were interviewed: a so called hill-tribe known as Hmong and a local people known as Khon Muang. The random sample consists of 200 households; 142 local northern and 58 Hmong households. Principal component analysis (PCA) is utilised to determine the important factors affecting household poverty. Furthermore, a poverty index is developed.

The PCA retained 16 out of 65 possible poverty determining variables. Six of the 16 variables relate to the human resource factor: (1) percentage of adults who can write, (2) percentage of adult completed primary school, (3) percentage of adults with non-farm occupation, (4) number of children, (5) percentage of unemployed to employed, and (6) family size. There are two variables relating to food security that were significant: (7) crop yield and (8) value of main crop yield. Four variables relating to the dwelling show a high correlation to poverty. These are the (9) housing condition, (10) quality of latrine, (11) water system, and (12) furniture. Four variables related to assets: (13) value of transportation assets, (14) farm land owned, (15) value of assets per adult equivalent, and (16) value of agricultural assets.

The explicit factors, relevant to assess poverty are the dwelling conditions, assets, human resources, and food security respectively. The factor, which can turn the poor become even poorer is the human resource factor, where e.g. the number of dependents is comprised. The poverty comparison between farm households living in the highlands and lowlands found that Hmong households, which normally live in mountainous regions, are relatively poorer than the local northern households. This finding leads to the conclusion that factor analysis is very helpful in planning well-targeted and efficient poverty alleviation policies.

Keywords: Northern Thailand, poverty, principal component analysis

Postcommunist Gender Differences in Non-Farm Rural Employment — The Case of Bulgaria

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Bulgaria is a transition country, intending to join the European Union. After the fall of the communist regime, the societal position of women has been affected by reduced public spending and massive job losses. Consequently, women are increasingly engaged in the informal market. It is plausible that these negative effects are greater in the rural than in the urban regions because of the smaller number of opportunities to cope with the social and economic transformation and the subsequent negative effects for women. Lack of investment and infrastructure is hindering the rural areas from recovering as business is moving away into the urban parts of the country. The young and educated migrate to the cities, leaving the hope for improvement on the shoulders of the shrinking and aging rural population. For those, who remain, agriculture is usually the base for subsistence, but it is rarely sufficient to ensure an acceptable living standard and so the non-farm rural employment emerges as an exit of the poverty spiral.

In this context it is important to examine in which way and to which extent women and men use the non-farm rural sector to change their economic situation to the better. Moreover, this study analyses to what extent the transition process caused deterioration of the “iron gender equity” enforced by the communist regime. This study’s sample consists of 100 households in rural Bulgaria, most of which have non-farm income. The quantitative data was collected through standardised questionnaires. In order to gain deeper understanding additional qualitative interviews were conducted in 20 of the sample households. The determinants of gender differences are analysed on the basis of multinominal logistic regression models. Also, qualitative analysis will be used to complement the study. We will draw conclusions on policy implications of the results in regard to gender-differentiated non-farm rural employment: income differences, pattern of employment, and attitudes.

Keywords: Bulgaria, gender, non-farm employment, rural development

Socio-Economic Assessment of Arid Land Farming and Rural Development — A Case from Lake Nasser Region in Egypt

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Continuing increase of population and very limited land resources form a serious problem for the development possibilities in Egypt. Nearly the entire population lives on 4 % of the territory particularly on the Nile Delta and Valley which are narrow with limited capacity for further extension. Hence, the government's policy was directed to establish new settlements to extend the cultivated area through arid land reclamation. One of the main destinations for such extension and development was Lake Nasser area, because it has a high economic potential and population absorption capacity.

To ensure the establishment of suitable and sustainable development strategies for the area, this study assesses the actual socio-economic conditions of the already settling population, to better understand the obstacles to and advantages of settling in the area. The results may form the basis to better support the settlement activities in the area.

A focus is given to the socio-economic situation of the farm-families in the area. Therefore, the Farming Systems Approach was adopted to assess the socio-economic situation of the settling populations around Lake Nasser area with special emphasis on their potentials and problems. The data was collected through a survey by using a standardised questionnaire to 100 systematically selected families from two of the most potential villages in the area.

The current results showed that the families settling in the area differ in their socio-economic characteristics according to their settling behaviour. Accordingly they were classified into three classes: permanent families, seasonal farmers and occasional visitors. The economic analysis showed that the seasonal farmers are the most successful group because they have the highest farm income, they were the best to repay their financial obligations and they have the highest cash surplus. They were followed by the permanent families while the occasional farmers came last. Socially, the permanent families are the most affected group with inefficient social conditions and infrastructures in the area. The social conditions in the area do not have a big impact on the other two groups because they come to the area only for economic activities and have their main household elsewhere.

Keywords: Egypt, land reclamation, living standards, resources use, rural development, socio-economic analyses

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Can Credit Improve the Livelihoods of Resource-Poor Rural Households in Ethiopia?

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The population of the study area, Atsbi wemberta wereda in Tigray, northern Ethiopia, practices mainly subsistence farming and is highly dependent on food aid. The natural resource base is limited and consequently possibilities to enhance traditional agricultural productivity are scarce. To guarantee sustainable livelihoods, the poor have to diversify their range of income-generating activities. As these activities require basic capital to get started, access to credit is crucial as well as the type of credit. This paper reports on the findings of a survey in 97 households and 5 group discussions carried out in 2002. The survey examined the livelihoods of resource-poor households using either formal, informal or no credit, emphasis was laid on the impact of credit on female headed households. Survey results were analysed using SPSS.

Overall, households not using credit were the “wealthiest”, owning more big livestock and being the most food-secure of all interviewed households. The “poorest” group were households using informal credit as their only credit source. These households consisted to a greater part of female headed and younger households and depended on food aid and food for work to secure their households food consumption. Female headed households were more often using credit, be it formal or informal, on a regular basis. But more female headed than male headed households did state fear of risk as the main reason for not up-taking formal credit. Regarding access to credit it seemed that most respondents had no problems acquiring a credit from the local micro-finance institution, DESCI, when needed. But respondents were frequently asking for more flexible repayment schemes, and many former clients had left the scheme being discontent with the peer-grouping system. Another reason for discontentment was the fact, that DESCI does not provide any formal training, e.g. for animal husbandry or other micro-enterprise activities.

In order for credit to be successful in helping the mostly unskilled poor to improve their livelihood, training as well as more flexible repayment schemes seem to be a necessary precondition.

Keywords: Gender, micro-credit, sustainable livelihoods

The Alternative Means to Increase Farmer's Access to Credit: Case Study in Armenia

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An adequate access to financial resources is shown to be a critical precondition for the effective transformation and for the efficient performance of the newly created private agricultural sector in transition countries. However, due to traditional and transition related problems such as low enterprise profitability in agriculture, risk and uncertainty, and collateral problems, small scale farmers, particularly poor rural households, are practically excluded from access to credit and saving services.

The non - adequate access to financial resources leads to farmers' capability deprivation. Capability deprivation is often argued to be better measure of poverty because it can capture aspects of poverty hidden by income measures. It is widely acknowledged — and empirically verified — that income and aspects of human development (e.g. education and health) are strongly correlated, with the causality going both ways.

Empirical findings suggest that access to financial resources may be improved by the use of existing social structures of communities, such as farmers' social capital. If social capital is understood as a network and social, cooperative respect structure it requires an investigation in a form of network analysis. Understanding of networks can be an effective means for identifying and developing opportunities for improvement.

The aim of the research project is to understand how current credit situation is embedded into society, how farmers value and use existing social networks to reduce vulnerability and what makes them to act as they do taking into consideration the complexity of changing institutional relations (economic, political, agro-ecological and socio-cultural environment) within which rural livelihood is embedded. Based on findings, microfinance will be evaluated in its current form as a rural poverty reduction tool and as the benchmark how social capital can be addressed while designing optimal agricultural credit markets.

Keywords: Capability deprivation, microcredit, social networks

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Improving the Livelihood of the Rural Population in the Ashanti Region in Ghana through the Production of Grasscutter (*Thryonomys swinderianus*) Meat

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Ghana's transition forests, neighbouring savannahs and timber plantations in the Ashanti region face a constant degradation due to the increased occurrence of fires. In most cases the fires are deliberately set by rural people for hunting purposes. Main target is the grasscutter (*Thryonomys swinderianus*) whose bushmeat is highly esteemed throughout the country. The animal is a wild herbivorous rodent of sub-humid areas in Africa south of the Sahara. The grasscutter meat is an important source of animal protein. In Ghana its demand is very high and cannot be met.

The Institute for World-Forestry of the Federal Research Centre for Forestry and Forest Products, Hamburg is cooperating with a Ghanaian timber plantation company and the German Foundation for Forest Conservation in Africa with the purpose to improve the livelihood of the rural population in the surroundings of the forest plantation sites and simultaneously to safeguard and improve the timber plantations. As fire for hunting purposes of grasscutters was identified as the major risk factor for the timber plantations (mainly Teak, *Tectona grandis*) solutions had to be sought for the avoidance of fire.

The production of grasscutter meat carried out by local farmers in the plantation surroundings appeared to be a promising approach. For that reason farmers interested in grasscutter captive breeding were identified and trained in collaboration with a German Aid Project for Rural Development. After the successful completion of training courses the farmers received a few selected animals for breeding purposes. Project staff is regularly supervising the living conditions appropriate to the species. As basic market structures for bushmeat are existing in Ghana further emphasis will be put on the improvement of market access of the grasscutter producers.

Further investigations will evaluate the effects of the grasscutter rearing in the project region. Success of caging, reproduction rate and meat quality will be assessed as well as the reduction of fire and the improvement of rural livelihoods through income generated by the grasscutter production.

Keywords: Bushmeat, Ghana, grasscutter, livelihoods

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Agricultural Intensification, Labour Allocation and Social Change in Syria

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Syrian agriculture is a main pillar in the economy of the country, and population growth is among the highest in the region. Thus agricultural development during the last few decades was directed towards intensification of production using improved varieties, greater use of fertiliser and other inputs, introducing irrigation, diversifying production, reducing fallow area, and using mechanisation. As concomitants to intensification, were greatly affected the labour use and allocation in Northwest Syria. New land use patterns have emerged, increasing the volume of “traditional labour jobs” and developing new demands for “untraditional labour jobs” impacting the gender balance of agricultural labour. A descriptive model of agriculture and the gendered aspects of agricultural labour and the influencing factors together with the labour management and organisation are discussed in the paper. The methodology used is a combination of secondary data, informal and formal surveys. The results illustrate how the household related activities have been greatly modified. The social system has been modified based on economic needs in societies where perceptions about working outside the household boundaries are rapidly changing. Empirical observations provide contributions to the scientific debate on social transformation based on economic changes, impacting household economies. Improvements in productivity and yields are also the result of mechanisation that has contributed to the migration of rural population mainly male from rural to urban areas seeking better work opportunities, leaving women and children in villages to work in agriculture as family or hired labour. The increase in labour demand in agriculture concerns mainly a feminized labour force performing manual operations. The picture emerging from the discussion of this paper in relation to poverty, particularly that of rural women is complex. It is considered even alarming when we look at the workload left to them after the migration of men. But a gleam of hope appears from the local women’s networks for labour organisation and management, which constitute a niche for women’s concerns. Policy and other improvements of the conditions of women could be conveyed through these channels where important social capital is embedded, given that rural development specialists establish the link between these networks and decision-makers.

Keywords: Agricultural intensification, gender, labour, social change

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Gender Inequalities and their Implications for Living Standard and Food Security among Male and Female Headed Households in Imo State, Nigeria

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Both male and female participate in farming activities in Nigeria. The activities of women apart from cultivation, includes processing, marketing and livestock husbandry. Despite improvements in building women's capabilities, gender gaps in entitlements - the resources which women and men can command through available legal means - continue to persist. This is reflected in unequal rights between men and women for both natural and physical capital which leads to inadequate and inappropriate use of resources; and limited alternatives, low income, poor diets, low living standard. These disparities have serious consequences for well being, not only for women themselves, but also for their families and for society.

This study compares the resources available to male and female headed households, the use and productivity of these. In comparing them, the different roles and decision-making of men and women are described and defined. Also a comprehensive inside view of differences in environment (economic, administrative, social) and decision-making is given. The impact of these on living standard and food security are also examined.

The results show significant differences in resource availability especially land. Female heads of households are found to be more efficient with capital and labour use while male heads are more efficient with land use. The factors influencing gender roles and decision making differ between the two groups. While the male headed households have higher incomes and a relatively better living standard, their health situation is worse compared with female headed households. Perceptions of the food security situation indicate cultural preferences and taste for food; poor and unvaried diet. In both cases caloric availability is low and influenced by different factors.

Keywords: Decision making, food security, gender roles, male/female headed household

Modelling Decision Making in Communal Areas: The Identification of the Utility Function

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In the Kavango Region (North Namibia) the natural resource base is partly degraded depending on rainfall, population density and actual land use. The average rainfall is 550 mm per annum and the natural vegetation consists of dry forest and tree savannah. The dominant farming system can be described as a mixture of subsistence crop and livestock production. Villagers in this region face imperfect labour markets, high transaction costs and a pure infrastructure. Their nutrition is highly based on natural resources, is barely supplemented by purchased groceries and is frequently endangered by environmental conditions. The objective of this case study is to construct a dynamic bio-economic model of a communal village which evaluates alternative management options. The model is supposed to balance the trade-offs between the conservation of natural resources and food security for the inhabitants.

Production and consumption decisions are non-separable for peasant households in developing countries. Therefore, the objective function of the model is maximising utility subject to several constraints.

The focus of the present research phase is laid on identifying the utility function with a modified conjoint analysis approach. Conjoint analysis is a method that raises values for the overall utility on the basis of preference judgements of decision makers in a given choice setting. In general this method is used in market research. However, in this context it manages to uncover the preferences of decision makers for different household activities.

It is assumed, that livestock keeping represents the most important household activity. Particularly the extent of livestock numbers is supposed to contribute to utility on a high level. Moreover, preferences will be based on an adequate subsistence crop production and cash income generating activities.

The increase in livestock and field numbers will contribute to further degradation of rangelands and forests. This will cause a supplementary instability of the eco-system and thus the nutrition base. It is supposed that the subsequent modelling process will deliver more suitable management alternatives that generate a sufficient nutrition and conservation level.

Keywords: Conjoint analysis, decision making, nutrition level, utility function

Incomes, Expenditures and Nutrition Outcomes in Rural Kenya: Evidence on Intra-Household Resource Allocation

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Nutritional problems broadly fall into two categories: those resulting from insufficient intake of food relative to nutritional needs and those resulting from excessive and unbalanced intake of food or a particular dietary component. For Kenya, undernourishment is one of the challenges facing many rural as well as urban households. Acute malnutrition afflicts 35 % of the population in the arid and semi arid areas and chronic malnutrition is as high as 45 %.

A growing body of literature suggests that men and women allocate income under their control in different ways. The implications of intra-household bargaining for nutritional outcomes depend largely on the bargaining power of men and women within the household. The purpose of this paper is to examine intra-household income distribution, expenditure on food and non food items and its implications for household food and nutrition security. Special attention is placed on the impact of paternal and maternal income on caloric consumption and child anthropometric outcomes. The major hypotheses to be tested here are: increase in household income would increase expenditure on food and hence increase in per capita calorie intake in households and; there is unequal distribution of food within the household as a result of low income under the control of women. Therefore, an increase in women's income would contribute to equitable food distribution and increase per capita calorie intake.

Data from a household survey containing detailed gender disaggregated information on resource ownership as well as food and anthropometry are used in the analysis. The analysis dwells on shares of household budget spent on food and non food commodities, followed by individual nutrient intake and anthropometric analysis. The two stage least squares regression is used to analyse the determinants of nutritional status. Pearson correlation coefficient is used to determine the relationship between income and nutrition outcomes as well as caloric intake within the household.

Keywords: Kenya, income, nutrition

Economic Situation of Family Farms with a Focus on Grapes Production - A Case Study of Georgian Republic

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Political independency of Georgian Republic still has tremendous economic effects on agricultural production and farm families income situation. Grape production in the Georgian Republic decreased from about 900,000 t harvested per year in 1998 to about 100,000 t harvested per year today. The acreage of vineyards halved in this time. The production intensity in form of use of fertilizer and pesticides sharply diminished and liquidity posed a big problem to the family farms. The presented paper analyses the situation and development possibilities of family farms in the Georgian Republic with a focus on grape production.

Data were collected in Khashuri region on five family farms. For data collection a standardised questionnaire was used which covered the areas of resources, production, capital and decision making. For the analyses calculations of gross margins, total costs, income as well as static investment calculations were used. As computer programs the office-family of Microsoft and Max and BEP which are specific agro-economic programs developed at the University of Applied Sciences Weihenstephan were used.

The analyses showed a high percentage of manual labour used in the vineyards. The performance of the farm production shows, that the farms can achieve a profit but costs for their own resources are not satisfactory covered. A main focus is given to market relations since prices for produced grape of same quality differ highly between the single family farms. The demand structures for grape are characterised by oligopolies.

Two improvements to reduce manual labour on the farm were more closely surveyed. One was the use of a new technique to reduce time to tie the vine. The other one was the introduction of a vineyard tractor to reduce costs for hired labour. The analyses proofed the high profitability of the use of a vineyard tractor. The paper also discusses the pros and cons of the possibility to introduce these machines into practice.

Keywords: Family farms, Georgian Republic, economic assessment, grapes

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Conservation Agriculture (CA) in Southern and Eastern Africa: A New Approach to Facilitate Adoption

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Major rural areas in Eastern and Southern Africa are continuously affected by soil fertility decline due to inappropriate management of the natural resource base and the low inherent fertility of soils. Furthermore, an increasing depletion of soil organic matter on arable land has been observed during the last decades.

Conservation Agriculture (CA) has been tested for many years in the Americas and Australia. It has been proved to be an effective technology to counteract fertility deterioration. CA aims to minimise soil disturbance, maintains ground cover by keeping residues and crops on the soil surface, promotes crop rotations and, where appropriate, incorporates green manure cover crops into the system. Consequently, CA improves soil fertility and soil organic matter contents, minimises soil erosion, increases infiltration, maintains a higher soil water status during seasonal droughts, helps to decrease crop failures and therefore contributes to food security in rural areas.

While the land area cultivated under CA in the Americas and Australia is constantly growing, adoption was low in Southern Africa. A new CIMMYT project funded by the BMZ started in August 2004 as a whole experiment to find out the drivers that facilitate the adoption of CA in Eastern and Southern Africa. Components of this new project are: The development of innovation networks with multiple stakeholders (public, private, NGOs, universities etc.); community awareness and farmer training; participatory demonstrations and on-farm research; participatory machinery evaluation, modification and local manufacture; farmer experimentation and farmer-to-farmer exchange; change agent and researcher training; PhD studies (socio-economics and soil ecology) and medium-term trials to study the effects of CA on soil quality.

Keywords: Conservation agriculture, fertility decline, organic matter depletion, soil quality, Southern Africa

Developing Private Research and Extension Designs in Benin: Review of Three Case Studies

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Liberalisation and privatisation are often perceived as the way to improve the effectiveness and the efficiency of service provision. In many developing countries, policies are being oriented according to this with the expectation of making right progress in offering better services to farmers. Since 1991, many steps were taken to liberalise the agricultural services in Benin. A privatisation of research and extension, although hardly noticeable, is progressively going on in the country. Surveying three cases, this paper highlights the diversity of **(i)** actors involved in the process, **(ii)** services provided to farmers, **(iii)** service delivery systems, and **(iv)** approaches of integrating farmers in the financing of the organisation of services. Overall, bunches services to meet the needs of farmers are often provided, partnerships to balance technical weaknesses are sealed up and farmers are invited to share the costs of the direct implementation of the activities. Nevertheless, development projects, farmer organisations and Non Government Organisations use different specific strategies to achieve their goals. Public institutions are taking part in the private extension, using their long and broad experience to offer technical competences. But whether the confidence relationships between the partners take place for an agricultural development remains a crucial issue. This study provides evidence that for different reasons - not always related to agricultural production - farmers are willing to pay for services, even for public services. Furthermore, farmers are not invited to share costs with the intention of reinforcing their position, but more of solving financial problems and of ensuring a so-called sustainability. More effort should be made to better direct the privatisation of agricultural research and extension in Benin so as to develop true accountability mechanisms.

Keywords: Accountability, Benin, cost sharing, private research and extension, willingness to pay

Improvement of World Wide Communication by Codification of Plant Growth Stages: BBCH-Code of the Rubber Tree *Hevea brasiliensis* (Willd. ex Adr. de Juss.) Muell.-Arg.

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The detailed description of developmental stages of useful plants followed by adequate codification facilitates communication between scientist and practitioners if e.g. new findings of science have to be transferred to management procedures or if experiences made at one growing site have to be adapted to another. Native to the South American Amazon region the rubber tree was introduced to many other tropical regions of the world at the beginning of the 20th century, like China, Indonesia, Malaysia, Liberia, India, Ivory Coast, Sri Lanka, Sarawak, and Thailand. There are many improved varieties and cultivars in areas where the rubber tree is cultivated commercially. We describe the growth stages of the world wide grown rubber tree (*Hevea brasiliensis*) to prepare the basis for comparisons of epidemiological studies of disease, of growth patterns under different environmental factors and of genetic clone specific parameters. Each growth stage presented from seed germination to crown development and harvest is correlated with general management practices. This scale may be of great help to rubber growers and researchers around the world for more efficient planning of management practices and experiments. The codification follows the “Extended BBCH-Scale”, a numerical system which differentiates between principal and secondary growth stages. The extended BBCH-scale is a system for a uniform coding of phenologically similar growth stages of all mono- and dicotyledonous plant species. It results from teamwork between the German Federal Biological Research Centre for Agriculture and Forestry (BBA), the German Federal Office of Plant Varieties (BSA), the German Agrochemical Association (IVA) and the Institute for Vegetables and Ornamentals in Grossbeeren/Erfurt, Germany (IGZ). The abbreviation BBCH derives from Biologische Bundesanstalt, Bundessortenamt and Chemical industry. BBCH codes are recently well established for more than forty species and used in agricultural practice, agrometeorology, climate change observations or agricultural insurance.

Keywords: BBCH-scale, codification, growth stages, Hevea, phenology, rubber

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Analysing the Integration of the Village Level Participatory Approach into the Extension System in Benin

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Since 1985, the Training and Visits System (TVS) has been the cornerstone of agricultural extension approach in Benin. The use of TVS helped particularly to improve cotton crop production, and made it the most important cash crop in the country. However farmers displayed an evident disaffection for extension activities because their real needs were not taken into account. To better address the needs of farmers, the Village Level Participatory Approach (VLPA) was developed and experimented with the support of the World Bank. This experimentation involved 600 villages from 1999 to 2002. A plan is made to generalise it to the whole country. This paper analysed the strengths and weaknesses of the integrated approach, basing on its implementation in 17 villages in Bembereke district in the North Benin. Analysis showed that the VLPA tended to reinforce the resources management and auto-promoting capacities within the rural communities. In contrary, TVS focused on individual farms and targeted the increasing of the productivity and income through the transfer and diffusion of innovations. Both systems required different methodology and professional capability from extension agents. While the TVS agents need great technical skills and knowledge on adult training, the VLPA call for better capability in group animation and survey. On the one hand, extension was not a high priority according to the participatory planning. On the other hand, except soil fertility problems, the others agricultural issues for which extension services are requested concerned only less than 36 % of the villages. Regardless this order and difference in priorities, the same extension topics were systematically developed in all the villages. To increase the efficacy of the integration of VLPA and TVS in Benin, the analysis and training capacity of existing extension agents should be reinforced and training topics should be decided on a case by case basis. This may require changes in the way the TVS was carried out. Lots of care should be also taken where dealing with sensitive issues related to health, water and infrastructures. The VLPA is a valuable tool in Benin context, where a decentralisation process is going on.

Keywords: Benin, extension, integration, training and visit system, village level participatory approach

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Open Source Software Strategies in Development Cooperation

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With the still increasing globalisation and the integration of local markets into the global economy, information is more than ever a key factor for success. While computer based information systems are common practice in more developed countries they are still an exception in other parts of the world, particularly remote rural areas in developing countries.

Bridging this divide can not be reduced to the mere provision of internet access. Instead effective solutions like business information systems with localised content and specialised databases need to be developed.

Obviously these solutions do not only consist of information and content. A well suited IT infrastructure and strategy is the basis for such systems and necessary for a sustainable development.

Coming from a non IT background many actors of development cooperation focus on the content and information part. It seems as if not many efforts are spent on the underlying IT strategy and architecture.

On the other hand the UN, especially the United Nations Conference on Trade and Development (UNCTAD), specifically recommends the usage of Free/Libre and Open Source Software (FLOSS) for development. The E-commerce and Development Report 2003 for example discusses the advantages and reasons for the usage of Open Source Software. At the same time many civil services as well as companies in Europe and North America switch over to use FLOSS instead of proprietary solutions.

With this background we are analysing the awareness of different actors and agents in the development communities — including those in rural areas — about the importance of IT strategies in general and, more specifically, about Open Source Software strategies.

In “dry exercises” based on the available literature and by using techniques like SWOT and SINFONIE actors and agents are analysed and clustered. By means of case studies of different development projects the actors’ attitude towards the underlying IT infrastructure are being investigated. Special attention is drawn to possible relationships between a country’s IT policy and the actors’ attitude towards IT strategy questions.

Keywords: Development countries, ICT strategies, information technology, open-source software, rural development

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Scientific Networking to Combat Desertification — Creating Interdisciplinary and Participatory Bonds to Sustain Rural Livelihoods

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Natural resources are still the major economic backbone of most rural households in arid, semi-arid and dry sub-humid regions. Multifarious social, economic and political reasons especially during the last century have supported the policy of maximum utilisation of these resources. This has resulted in the widespread disruption of farming systems up to the point of desertification. Field research in drylands emphasises the importance of interdisciplinary and participatory-based research approaches to combat and to prevent desertification for stabilising the rural production systems. The German Scientific Competence Network for Research to Combat Desertification (Desert*Net) was established to form a binding link between different scientific fields, policy makers, development agencies, public institutions and stakeholders in order to support applicable sustainable land use systems in degraded areas. Desert*Net recognises mono-disciplinary excellence as the pre-stage for aggregating reliable information for interdisciplinary research. Desert*Net identifies pressing desertification-related issues at the social, economic and political level. This network scientifically supports innovative research concepts that are feasible and applicable to the local realities in desertification-prone areas. For this reason member institutes of Desert*Net co-operate with countries affected by or prone to desertification in the line of technical and methodological training, scientific knowledge transfer and applied field research.

The Desert*Net member project BIOTA Southern Africa (www.biota-africa.org) which is funded by the German Federal Ministry of Education and Research (BMBF) exemplifies, how the development of a new strategy helps to sensitise members of local communities in Southern Africa to the complex ecological and socio-economic causes and effects of desertification. New strategies in order to combat land mismanagement require the participation of local stakeholders in research for sustainable development. BIOTA Southern Africa for instance supplies community members with target information on ecological indicators. A major aim of the long-term training at eight rural communities is to encourage them to realise their own role in combating or preventing land degradation, as well as their expectations to other vital groups (science, political administration, development agencies). Incentives should be created for self-administration and income diversification which are in balance with local natural resources.

Keywords: Capacity development, desertification, inter-disciplinarity

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Information Management for Agricultural High Value Product Supply Chains

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Developing high-value-crop supply chains, such as coffee, has the potential to improve the livelihoods of poor rural farmers in less developed countries. Systematic information management can greatly facilitate supply chain development by, for example, linking a speciality market in one country with potential producers in another. In this paper we describe the development of a prototype information management system for speciality coffee supply chain participants. We then describe future work to further develop it so as to better meet users' needs. And finally investigate and introduce tools and approaches appropriate to filtering information useful for making short- and medium-term agronomic and marketing management decisions.

The prototype CinfO system (a virtual discussion space for stakeholders worldwide interested in the diversification of hillside coffee-growing areas) consists of two parts: a central database and an Internet based user interface. Surveys were carried out to determine users' data requirements. A multi-user framework tailors information to users' needs in respect to data privacy by granting user specific access rights, language and visual needs. The prototype CinfO incorporates information about coffee production, farm management and coffee quality. A unique code system guides the data along the supply chain and guarantees traceability. The whole system is based on Internet technology, which enables quick and easy input and update of information of all participants in the supply chain in real-time. That is crucial in a highly dynamic market with constantly changing demands.

The long-term success of CinfO will depend on its ability to provide its users with relevant and timely data. Future development of the information system will extend the system with functions that facilitate Learning Selection methodology. These functions specifically address the ability of networks, as which supply chains can be considered, to generate information that permits more accurate and relevant decisions than could be derived from individual network members. The development and implementation of these functions requires communication between all chain participants to test, modify and continually improve the functions. The paper assesses the utility of different approaches to provide these functions, including for example Bayesian statistics and the Delphi method.

Keywords: Agriculture, Bayesian statistics, decision support, high value crop, information management, Learning Selection, speciality market, supply chain

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ICT/ICM Human Resource Capacities in Agricultural Research for Development in Eastern and Central Africa

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In Sub-Saharan Africa, agriculture accounts for 70 % of employment and is vital for the livelihood of the rural poor. Modern information and communication technologies (ICT) and appropriate information and communication management (ICM) are necessary to support agricultural research for development. Information technologies are evolving quickly, however human capacities are lagging behind. Therefore, the Regional Agricultural Information Network (RAIN), one of the networks of the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), commissioned a team of consultants to undertake an assessment of ICT/ICM human resource capacities and related training needs in the context of agricultural research for development, funded through a grant provided by the Technical Centre for Agricultural and Rural Cooperation (CTA).

Between July 2004 and February 2005, we examined institutional ICT/ICM policies, human resources, and training needs at national agricultural research systems and related institutions within the ASARECA sub-region through visits and interviews, questionnaire surveys, and desk studies.

The study revealed a general lack of institutional ICT/ICM policies which, in turn, affect human resource management strategies, commitment to ICT/ICM by managers, initiation and execution of ICT/ICM functions, establishment and management of ICT/ICM units, and status of ICT/ICM staffing. We found deficiencies in skills for accessing scientific and technical information; managing content, data, and information; disseminating and communicating information; and managing technologies. These deficiencies lead to a wide diversity of training needs throughout all ICT/ICM staff categories and occupations. Training is needed at various competency levels, especially at short-term, but also at diploma, graduate, and postgraduate levels. Fortunately, during our country visits, we noticed that most training needs can be satisfied with resources available in-house, in the country, or in the ASARECA sub-region. Our conclusions and recommendations stress the need for RAIN to continuously follow up and participate proactively on the global evolution of ICT/ICM. For solving infrastructural and skills deficiencies, the starting point is awareness building at institutional, national, and regional levels. For certain recommendations, we suggest specific action plans. We give profiles of resource institutions for training within and outside the ASARECA sub-region.

Keywords: Agricultural Research for Development, Eastern and Central Africa, Human Resource Development, ICM, ICT

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Distance Learning for Agricultural Development in Southern Africa

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Agricultural knowledge to improve food security, protect natural resources and reduce poverty hardly reaches small-scale farmers. Distance learning offers researchers and extension workers a chance to keep updated and to transmit information to farmers.

The Commonwealth of Learning (COL), Vancouver, Canada, in collaboration with the In-Service Training Trust (ISTT), Lusaka, Zambia, and with the advice of the Directorate of Distance Education (DDE), University of Zambia, Lusaka, Zambia, designed a programme with the goal “to contribute to sustainable improvement of food security and alleviation of poverty, while maintaining resources and environment, through access to knowledge by distance learning”. Two training workshops held in 2001 and 2002 at ISTT exposed participants — agricultural researchers, extension workers and educators from Namibia, Tanzania, Uganda, and Zambia — to distance learning, and to design distance learning materials and programs. The content was “Agronomic management of cowpea and soybean in Southern and Eastern Africa”. Between the workshops, a pre-test ensured that the programme addressed the target audience: the frontline extension workers. The pre-test confirmed relevance, importance, acceptability, and user friendliness of the learning materials. It also showed information gaps and deficiencies in content and editing. During the second workshop, the participants analysed the pre-test results, communicated with local frontline extension workers, and improved their distance learning materials. Subsequently, between May 2003 and February 2004, depending on the growing season of cowpea and soybean, collaborating regional training institutions initiated the programme on a pilot basis: the Kulika Charitable Trust, Kampala, Uganda; the Agriculture Training Institute Ukiriguru, Mwanza, Tanzania; the University of Namibia; and the Zambia College of Agriculture, Monze, Zambia. Lessons learned from the pilot implementation included aspects of management of funding, reproduction and distribution of learning materials, advertisement of programs, recruitment of learners, distance learning, residence study and practice, learner support, and achievements. The training institutions consider now to integrate distance learning into their mainstream activities.

Keywords: Agricultural development, agricultural extension, agricultural research, agricultural training and education, open and distance learning (ODL), Southern Africa

Does Farm Labour Organisation Affect the Adoption of Integrated Pest Management (IPM)?

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Integrated Pest Management (IPM) is an important component of sustainable agriculture. Farmers who switch from a more capital-intensive pesticide-based pest management strategy to IPM have to substitute capital with labour. The adoption of IPM will therefore depend, among other things, on the opportunity costs of labour. Labour in agriculture is often divided between the owner-operator, his family members, and hired permanent or seasonal workers. Whether a certain task is carried out by the owner or somebody else depends mainly on differences in the opportunity costs and transaction costs of labour. Although the adoption of IPM has been studied frequently, the importance of labour organisation has been overlooked so far.

This paper is an attempt to examine an empirical evidence of a theoretical economic model of the effect of labour organisation on IPM adoption developed by Beckmann and Wessler in 2003. We use cross section data collected from the participatory farming system survey of 150 durian growers in Chanthaburi, Thailand, between March – April 2005. Durian growers have been selected using stratified random sampling according to the number of labour organisation form commonly found in Chanthaburi province. In contrast to many studies of IPM adoption, this work uses the form of farm labour organisation as endogenous factor for identifying the rate of IPM adoption of durian growers. Instrumental variables method was employed to relate econometrically the opportunity cost and a set of suspected variables as instruments of labour organisation to the rate of IPM adoption of durian growers.

In this ongoing empirical research, we expected that, *ceteris paribus*, the rate of IPM adoption is lower in farms where the decision maker faces higher opportunity costs of labour (e.g. work off-farm).

Keywords: IPM adoption, labour organisation

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Diffusion of Information on Innovations in Agriculture

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Using participatory training approaches to improve farmers' knowledge on integrated production and pest management (IPPM) technologies is perceived to be more costly than alternative less intensive approaches of knowledge transfer. In addition benefits depend on the diffusion of knowledge within the village community. However, several empirical studies found that knowledge generated by participatory extension training does not always sufficiently diffuse to non-participating farmers. On the other hand diffusion of information has high potential for the successful introduction and establishment of an innovation.

A case study, conducted in two villages in Senegal in 2004, investigates the effects of training intensity on the diffusion of information. A total of 341 vegetable growers were interviewed in two villages that had different shares of trained farmers (14 % and 3 % trained farmers) but are similar in all other respects. The objective of the study was to analyse the factors determining the quantity and quality of information diffusion. A set of predominantly closed questions was used to generate data on demographic, farm-related, IPPM-related, and information-related issues, which are considered important to capture the diffusion processes. The data has been analysed using a logistic regression model as well as the ordinary OLS-estimation model.

The results show that the proportion of farmers who were trained affect the dissemination of IPPM-related information. The higher share of trained farmers in a village increases the individual exposure of non-participants. As a result, the likelihood of receiving information about IPPM is four times higher in village 1 than in village 2. Consequently, the number of exposed farmers approaches 100 % in village 1 and in addition, the quantity and quality of information that is shared is higher. Further, the findings suggest that information induces a higher demand for more knowledge by stimulating the intrinsic motivation of non-trained farmers to adopt IPPM.

Keywords: Diffusion, farmer training, knowledge and information, Senegal, West Africa

Empowerment of Rural Women through Participation in Sthree Shakthi Groups and its Influence on Decision Making : A Socio-Economic Study in Southern India

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The study assessed the empowerment of rural women through participation in Sthree Shakthi groups (SSG), a government / NGO sponsored rural women empowerment self help group programme, and its impact on decision making role of women in agriculture. The primary data were collected from 90 stratified randomly selected households comprising equal number from Large farms (LF), Small farms (SF) and Agricultural Labour (AL) categories - 15 SSG members and 15 non- members from each category. A composite empowerment index was constructed to assess level of empowerment of rural women. Logistic regression was employed to determine the probability of women participating in decision making.

The study showed that SSG are positively impacting the empowerment of rural women. The socio-economic factors like education, asset ownership, work participation and access to credit were found to significantly influence the empowerment of women. SSG member women had higher level of empowerment compared to the non-members. Further, women of SF and AL categories had higher level of empowerment compared to LF women. While the social empowerment was achieved through greater participation in community and social organisations, the economic empowerment was through greater access to credit and increased employment status.

Among SF and AL groups, participation of women in farm production decisions was in the form of 'joint' and 'independent' decisions, where as it was in the form of 'opinion sought' and 'opinion considered' in case of LF group women. The difference in production decision scores between SSG members and non-members was significant in case of SF households. Women did not have a major role in farm financial decisions, but their 'opinion sought' in the decision process. Explanatory variables like age, education of woman and that of husband, employment and empowerment had positive influence on the decision making role of women. Husband being alcoholic, number of adult males in the family and size of land holding were found to adversely influence the role of women in decision making.

Keywords: Decision making, sthree shakti group, women empowerment

Impact Assessment of Two Poverty Reduction Projects in Nigeria Confirms Participation as Key Component of Strategies for Poverty Alleviation

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Incorrect Information about a problem is identified as bottleneck to problem solving. Poor understanding of the roots causes of a problem is energy and time wasting. Historical analysis of community work shows suspicion between researchers and communities in Nigeria based on poor analysis, un-fulfilled promises and poor results of development strategies caused by a top down approach.

An impact assessment of two projects in Nigeria (Zamfara Grazing Reserve and Benue Agricultural Development Program) both used bottom up approaches; provided forums for greater rapport and intensive involvement of participants. Greater dialogue between Fulani nomads and sedentary Hausas in the grazing reserve was mirrored in Benue where researchers and farmers created room for greater understanding of their common problems, generating collective ideas for solving them, developing broad ownership of solutions and putting in place credible monitoring strategies. Post implementation assessments showed high levels of sustainability in the implementing of agreed strategies.

Involvement of stakeholders recognising gender, age, cultural barriers, and socio-political differences of 'community members' helped diminish social constraints allowing the cross-fertilisation of ideas. Inspired by the process and results, external partners have helped to provide communities access to basic services through enhanced participation in the process of national development. Leading to higher living standards and providing basic premise upon which the Nigeria Federal Government is expecting both the NEEDS and SEEDS to be achieved.

Keywords: Acceptability of change strategy, cultural barriers, gender concerns, impact assessment, poverty reduction, participation as key strategy, poverty alleviation, social impediments

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