Tropentag 2006

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

Prosperity and Poverty in a Globalised World — Challenges for Agricultural Research

Book of Abstracts

Editors: Folkard Asch, Mathias Becker

Implementation: Andreas Deininger

University of Bonn,

October 11-13, 2006

Impressum

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

Prosperity and Poverty in a Globalised World — Challenges for Agricultural Research: international research on food security, natural resource management and rural development; book of abstracts / Tropentag 2006 Bonn.
Hrsg.: Folkard Asch, Mathias Becker

ISBN: 3-937941-08-8

Editors:
Folkard Asch, Mathias Becker, Andreas Deininger, Prathap Pugalenthi

Layout:
Andreas Deininger, Folkard Asch

Typesetting:
LaTeX 2ε

Bonner Agrikulturchemische Reihe (BAR), Bonn

Printed by:
Hausdruckerei der Universität Bonn
Am Hof 1
53113 Bonn

September 2006

Preface

The TROPENTAG is the International Conference on Research on Food Security, Natural Resource Management and Rural Development - 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 (ATSAF) and the GTZ Advisory Service on Agricultural Research for Development (BEAF). The TROPENTAG 2006 is the eighth annual meeting providing a forum for young scientists, students and experts from Germany, The Netherlands, Austria and Switzerland and from the developing world involved in research for development. The conference theme is "Prosperity and Poverty in a globalized world: Challenges for international agricultural research".

The process of globalization is improves the access to knowledge and information, and, in part, to global markets. But globalization implies also the awareness of global implications and "off-site" effects and hence the taking of responsibility for the action of individuals, groups or organizations regarding resource use and misuse. Land, freshwater, energy, and biodiversity in natural and agricultural ecosystems are resources increasingly at stake. This leads to a global use of local resources, with global actors increasingly dominating the competition for access to these resources. Conflicts for land and water, energy and genetic resources are ongoing in many parts of the developing world. While globalization and rapid advances in research are meant to benefit mankind at large, there are in reality winners and losers. For example, the globalisation of food markets and the regulations of production favour 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 while smallholder agriculture serves domestic demands.

In view of 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. Such efficiency gains must be combined with an improved equity in resource access to allow all stakeholders to benefit from globalization and to avoid further conflicts for resources. With complex socio-ecological interactions, the research and development efforts must increasingly look beyond disciplinary and geophysical boundaries to contribute to the Millennium Development Goals. In this context, international agricultural research is seen to provide methods, technologies, approaches and new impulses to allow rural populations to sustain income and pro-

duction in harmony with nature, while providing sufficient quality food, clean water and energy and a healthy environment to cities. A multitude of new issues arise in the field of resource definition, allocation, and use. Who is left out in the process of globalization and why? What are the implications for urban and rural livelihood? What are on-site and off-site effects on the environment and natural resources? What can international agricultural research do to maximize the benefits of globalization without marginalizing a segment of the population or to balance the growing need for the production of sufficient, high quality food for an increasing world population with concerns for the environment?

The TROPENTAG 2006 is provides a forum to discuss the globalization theme in relation to issues of livelihood, poverty and agricultural land use. Participants present new scientific findings in different areas of international agricultural research, and can interact with donors, policy makers and fellow scientists. In this regard, the Tropentag 2006 is seen to contribute the political aims of poverty alleviation, food security and environmental protection as well as to intercultural dialogue and exchange.

The organisers are overwhelmed by the large number of submitted contributions from more than 700 scientists coming from 72 countries in Europe, Africa, Asia and Latin America. This large international interest underlines 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 at www.tropentag.de. The organisers acknowledge the generous support by the following institutions:

- Bayer Crop Science
- 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 Phytomedizinische Gesellschaft e.V.
- NRW Stiftung Natur-Heimat-Kultur — Foundation for Nature and Culture, North Rhine Westphalia
- Stiftung Internationale Begegnungen der Sparkasse Bonn — Foundation for International Encounters and Cultural Exchange
- Vater and Sohn Eiselen Stiftung - Eiselen Foundation Ulm
- Association for the Promotion of ARTS e.V.

Bonn, September 2006
for the Organising and Scientific Committee

Mathias Becker
Folkard Asch
Richard Sikora

Contents

Plenary Session

13:20 HANS VON GINKEL, Under-Secretary General of the UN, Rector of the United Nations University in Tokyo, Japan

13:50 MARITTA VON BIEBERSTEIN KOCH-WESER, Founder and President of Earth 3000, Chief Executive Officer
Global Exchange for Social Investment

14:20 *in memoriam* Sir Hans Singer
FRANZ HEIDHUES, University of Hohenheim, Germany

14:30 SIMON MAXWELL, Director, Overseas Development Institute London, UK

Development Economics

Markets, Liberalisation and Policies

Trade Liberalisation, Non-tariff Barriers and Market Access

ARNAB K. BASU
College of William and Mary, Economics and Public Policy, United States

Does trade liberalisation leads to increased market access for producers in developing (Southern) countries into the consumer markets in developed (Northern) countries? From the viewpoint of neo-classical trade theory, trade liberalisation should generate increased production efficiency for Southern exporters and lead to an increase in the volume of trade. However, empirical evidence over the past decade suggests a growing marginalisation of smaller producers and poorer farmers in Southern countries as they find their access to Northern markets restricted. It is thus worthwhile to ask whether conventional trade barriers have been replaced by non-tariff or hidden barriers to trade in the form of product labeling, imposition of traceability criteria and global value chains, and if so whether there exists **(i)** strategic export rivalry amongst Southern countries to develop their own or implement Northern standards to gain access to Northern markets, **(ii)** evidence that these schemes (labeling, traceability and value chains) favour larger and more organised Southern producers at the expense of their poorer counterparts, **(iii)** evidence that certain types of products are relatively more vulnerable in terms of gaining access to Northern markets, and (**iv**) co-ordination problems amongst Northern countries with regards to the enactment and implementation of product standards.

Keywords: Consumer markets, global value chains, product standards, trade barriers

Contact Address: Arnab K. Basu, College of William and Mary, Economics and Public Policy, P. O. Box 8795, VA 23187 Williamsburg, United States, e-mail: akbasu@wm.edu

Standards, A Catalyst for the Winners - a Barrier for the Losers? An Empirical Analysis of the Impact of Higher SPS Measures on the Trade Performance of Developing Countries

CHRISTINE CHEMNITZ[1], NANA KUENKEL[2]

[1]*Humboldt-Universität Berlin, International Agricultural Trade and Development, Germany*

[2]*Humboldt-Universität Berlin, Agricultural Economics and Social Sciences, Germany*

Within the debate about developing countries export competitiveness the increasing importance of food safety and quality standards especially in OECD countries is a major source of concern. The paper analyses the trade performance of 73 developing countries within the context of stricter SPS measures. The analysis concentrates on the meat and fruit/ vegetable sectors as especially high value product sectors are determined by standards. The periods under consideration are 1993–1995, a period before the implementation of the SPS Agreement and 2002–2004, after the implementation. Cluster analyses group the countries according to the variables "ratio" and "difference" of the export value to OECD countries between the two time spans, thus describing trade performance regarding to the absolute level of change and relative dynamics. Subsequently, relations with EU and US border rejections and with STDF (Standards and Trade Development Facility) investment are explored. Four major findings should be underlined: 1) The group of developing countries shows both in total and in relative terms a very heterogeneous picture of their export development and there is no linear relation between total export value and direction of development. 2) Ten groups were identified for both markets in the cluster analysis, e.g. small winners (in the fruit/ vegetable market e.g. Uganda), large winners (in the meat market e.g. Brazil), large losers (in the fruit/ vegetable market e.g. Thailand). 3) Most large exporters increased their market share, but very successful groups were also found among small exporters especially in the fruit/ vegetable sector. 4) Both, border rejections and STDF investments did not reflect a particular structure related to market share development of individual countries. The data for border rejections indicates very different strategies in adjusting to standards. Among the large, dynamic exporters for example, countries with a high and low number of rejections are found. Total investment of the STDF in individual countries is enormously high, while other countries in the same cluster show low or no investment. Future research should focus on single product level.

Keywords: Cluster Analysis, Competitiveness, Developing Countries, food Safety, SPS

Contact Address: Christine Chemnitz, Humboldt-Universität Berlin, International Agricultural Trade and Development, Luisenstraße 56, Berlin, Germany, e-mail: christine.chemnitz@agrar.hu-berlin.de

Coffee Cultivation in the Presence of Market Imperfections: an Analysis of the Factors That Determine Productive Efficiency of Coffee Farmers in Costa Rica

MEIKE WOLLNI[1], MANFRED ZELLER[2]

[1]*Georg-August-University Göttingen, Institute of Rural Development, Germany*

[2]*University of Hohenheim, Institute of Agricultural Economics and Social Sciences in the Tropics and Subtropics, Germany*

World market prices for coffee dropping to their lowest level in a century have casted the economic sustainability of coffee production into doubt. Given increased competitive pressure in the coffee sector, an efficient organisation of the production process becomes essential for farmers to stay in business. The current paper seeks to identify those farm and farmer characteristics that explain differences in technical efficiency among farmers.

Technical efficiency is usually associated with farmers' management skills. As the timing of maintenance activities and fertiliser applications matters in the production process, timely availability of labour and liquidity are key factors to achieving productive efficiency. As a consequence, imperfect labour and capital markets limit farmers that do not dispose of sufficient family labour or liquidity sources in their ability to produce efficiently. If market access is associated with high transaction costs, cooperatives can be an effective means to overcome these constraints. As concerns liquidtiy constraints for example, coffee cooperatives in Costa Rica provide farmers with short term credit in the form of fertilzers and other agro-chemicals.

Primary data from 216 coffee farmers in Costa Rica is being used for the econometric analysis. We simultaneously estimate a stochastic frontier model and the effects of a range of farm-specific variables on technical efficiency levels. Our model does not support the hypothesis that missing access to labour markets is a major constraint in coffee production in Costa Rica. We find some evidence that liquidity constraints lead to decreased efficiency levels. Farmers who pursue other income-generating activities besides coffee that provide them with liquidity attain higher levels of productive efficiency. However, the effect of total farm size, which is used as an indicator for wealth, on productive efficiency is not significant. The analysis further reveals that membership in cooperatives plays an important role in helping farmers to produce efficiently. Therefore, specialised coffee cooperatives should be fostered to provide farmers with access to productive resources and information, whenever market failures prevail.

Keywords: Coffee production, cooperatives, market imperfections, stochastic frontier analysis

Contact Address: Meike Wollni, Georg-August-University Göttingen, Institute of Rural Development, Planckstraße 15, 37073 Göttingen, Germany, e-mail: mwollni1@gwdg.de

High-value Food Supply Chains, Food Standards and Small Farmers in Developing Countries. the Case of Horticulture Exports from Senegal

MIET MAERTENS
Catholic University Leuven, LICOS - Centre for Transition Economics, Belgium

Agricultural supply chains are changing globally with increased importance of food standards, increased vertical coordination and large modern retail chains. The impact of these changes for developing countries and for small farmers in those countries is not yet well understood. We analyse the developments in high-value, high-standards food supply chains and the effects for small farmers and rural households for the case of horticulture export production in Senegal. We use a unique dataset derived from company level interviews and household surveys in the main horticulture zone in Senegal. Pervasive food standards have lead to structural changes in the supply chain with a shift from contract-farming with small-scale producers to large-scale vertically integrated estate-farming. A comprehensive econometric analysis shows that the restructuring of the value chain has enhanced an equitable distribution of rents among the rural population. Contract-farming, on the one hand increases the gains from high-value production and trade that accrue to the rural smallholder population but on the other hand, leads to the exclusion of the poorest farmers. Estate-farming and associated rural employment have a smaller (albeit still significantly large) effect on rural incomes and probably increase the rents from high-value agricultural trade that are extracted by large agro-industrial companies but add to the income of the poorest households. This challenges the argument made in the literature that high-standards food production needs to integrate small farmers as suppliers if it needs to benefit rural development and increase the welfare for the poor. Our study suggests that a dualistic structure in high-standards supply chains — with smallholder contract-farming and large-scale integrated estate-farming, and with small farmers integrated as suppliers and as wage workers — is most likely to bring about a balanced development impact with both equity and efficiency concerns addressed.

Keywords: Contract-farming, high-value supply chains, poverty, rural development, vertical coordination

Contact Address: Miet Maertens, Catholic University Leuven, LICOS - Centre for Transition Economics, Deberiotstraat 34, 3000 Leuven, Belgium, e-mail: miet.maertens@econ.kuleuven.be

Impacts of EurepGAP Standard on Vegetable Export Producers in Kenya

KAI MAUSCH[1], HERMANN WAIBEL[1], SOLOMON ASFAW[1], DAGMAR MITHÖFER[2]
[1]*University of Hannover, Development and Agricultural Economics, Germany*
[2]*International Centre of Insect Physiology and Ecology (ICIPE), Kenya*

As the export of fresh fruits and vegetables from Kenya targets, almost exclusively, the European market stricter regulations present a challenge for Kenyan agricultural export standards, like EurepGAP, introduced by the food industry. These standards have become more important in Europe and influence producer decisions in a developing country like Kenya. In this context the issue arises if producer standards help Kenyan horticulture export or rather act as a trade barrier to them and others. To address these issues a study has been conducted that investigates investments for meeting the standard and the process of compliance of small to large-scale Kenyan farmers. For this paper the central research questions are:**(1)** What determines the crop portfolio of each farm?, **(2)** What are the certification investments that the indi-vidual farmer has to bear? and **(3)** What determines labour organisation on the differ-ent farm types?.
The theoretical basis of the study is production theory including risk and institutional economics such as transaction cost theory and principle-agent models.
The study applies the concept of typical farm models to examine the impact of EurepGAP standard on three types of EurepGAP certified farms. The first model re-fers to small-scale farms that are normally organised in groups. The second model describes the large- and medium-scale farms contracted by an export company, which mainly produce for this company. Finally, the third model incorporates the farms that an export company runs itself. As these farm types are very different in many dimensions like the organisation of the farm, the structure of decision-making and especially the degree of vertical integration of the supply chain, it is necessary to differentiate them. The impact of EurepGAP standards on these three types of farms is analysed based on interviews of 19 large- and medium-scale private farms, 9 ex-porter owned farms and 47 smallholder farms in Kenya.

Keywords: EurepGAP, horticulture farms, Kenya

Contact Address: Kai Mausch, University of Hannover, Development and Agricultural Economics, Wilhelm-Bluhm Straße 45, 30451 Hannover, Germany, e-mail: kai.mausch@gmx.de

Poverty reduction and Development research

Knowledge Management in Development Cooperation

MATHIAS BRAUN, JOACHIM HOFER

Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Division 45 Agriculture, Fisheries and Food, Germany

The main assets of organisations involved in development cooperation are the knowledge, experience and capacities of their staff. Therefore knowledge as an important ressource of an organisation has to be used efficiently in the day to day work of their personnel. The objective of knowledge management has to be a more systematic handling of knowledge. This means it has to be made readily available wherever it's needed.

One can differentiate technical knowledge (know what), know how, explicit (can be documented) and implicit (connected to people) knowledge. Knowledge management means that information are collected, validated and are made available to the staff in a structured form. For a consultancy company active knowledge management leading to widespread usage of our assets has high priority.

Important structural elements of knowledge management in a learning organisation are standardised products; internet based data banks that include e.g. reports, evaluations and other project documents (e.g. contracts, planning documents) and special events (e.g. workshops, trainings). They document mostly technical and explicit knowledge. Face to face communication is an important element to collect implicit knowledge (e.g. debriefing when change of personnel is taking place). The main target groups for knowledge management are staff, external consultants and specialists and the main customers.

An important source of data for knowledge management in a company engaged in development are recent learning experiences from ongoing and completed interventions in development cooperation (e.g. methodology, approach, benchmarks and contacts).

Keywords: Debriefing, explicit knowledge, implicit knowledge, knowledge management, technical knowledge

Contact Address: Mathias Braun, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Division 45 Agriculture, Fisheries and Food, Dag-Hammarskjöld-Weg 1-5, Eschborn, Germany, e-mail: Paul-Mathias.Braun@gtz.de

Modes of Delivery in Development Cooperation — Challenges for the Agricultural Sector

HELMUT ALBERT[1], GEORG SCHAEFER[2]

[1]*Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Division Agriculture, Fisheries and Food, Germany*

[2]*Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Division Economic Policy and Employment, Germany*

Millennium Development Goals (MDG), Poverty Reduction Strategies (PRS), a substantial increase in Official Development Assistance (ODA) and a higher quality of aid are major topics on the international development agenda. The Paris Declaration on Aid Effectiveness (March 2005) defines ownership, alignment, harmonisation, management for results and mutual accountability as basic orientations for both donors and partner countries. Until 2010 two third of aid shall be channelled through Programme Based-Approaches (PBAs). Sector-Wide Approaches (SWAPs) are the most prominent form of PBAs at the sector level. SWAPs very often combine traditional aid modalities (projects) with new financial instruments like basket funding, budget support and TA-pooling. Sector programmes in agriculture have experienced both successes and failures. There are a lot of challenges ahead in order to transform the sector programme approach into a powerful instrument for agricultural development. Agriculture as a productive sector requires strategies that might differ from the concepts for social sectors like education and health. Legal, regulatory and institutional framework conditions and the role of private stakeholders are at least as important as the volume and allocation of public expenditures. On the one hand agricultural research should be an important sub-sector in a full-fledged agricultural sector programme. On the other hand research could contribute quite a lot to further develop the sector approach in agriculture. Basic conclusions and recommendations in this regard will be presented.

Keywords: Agricultural Research, Basket Funding, Budget Support, international Development Agenda, Millennium Development Goals, Paris Declaration, Poverty Reduction Strategies, Programme-Based Approaches, Sector Programmes in Agriculture, Sector-Wide Approaches

Contact Address: Georg Schaefer, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Division Economic Policy and Employment, Dag-Hammarskjöld-Weg 1-5, 65760 Eschborn, Germany, e-mail: georg.schaefer@gtz.de

Value Chain Promotion for Sustainable, Significant Pro-poor Growth: Conditions and Research Needs

ANNEMARIE MATTHESS[1], ANDREAS SPRINGER-HEINZE[2], STEFANIE ZINSMEYER[2]

[1]*German Agency for Technical Cooperation (GTZ), Project Support to the Management of National Agricultural Research Benin, Benin*

[2]*German Agency for Technical Cooperation (GTZ), Germany*

It is generally accepted that strengthening value chains in agri-business provides economic benefit to the involved value chain operators. Strategies, impacts (i.e. total and individual net increase of poors' income through value addition) and efficiency (i.e. invested time and resources compared to impacts) of value chain promotion should be analysed a priori on the basis of the aforementioned parameters.

The dimension of economic benefit depends on the size of the market segment, quality requirements, and competitors, in particular on their performance and ability to influence the market as well as to satisfy buyers and consumers. Chances for significant pro-poor impacts increase with the number of involved poor value chain operators, i.e. small scale producers, processors, service providers and traders. Even if their technical and economic performance is competitive, the degree of horizontal collaboration and their bargaining power within the value chain is crucial for their income increase.

International and urban markets in developing countries offer many opportunities for agri-food value chains. The latter are still mainly supplied by local production, but frequently information and consequently coherent policy, investment promotion strategies, governance structures and technologies to compete with imports are lacking. Under these conditions, it is difficult to determine more precisely their potential compared to international markets.

The argumentation leads to several research issues:

- Economic and social impacts of ongoing value chain promotion targetting both at local/urban and international markets
- Trends of demand, quality standards and consumption patterns of urban agribusiness markets in developing countries and opportunities for value chain promotion, innovative products
- Investment strategies in terms of policies, capital, services and technologies
- Access to relevant technological knowledge and market information,
- Combinations of sector and territorial approaches of economic development and their potential for sustainable rural economic growth,

Keywords: International and urban markets, pro-poor growth, value chains

Contact Address: Annemarie Matthess, German Agency for Technical Cooperation (GTZ), Project Support to the Management of National Agricultural Research Benin, 08 B.P.1132 Tri Postal, Cotonou, Benin, e-mail: annemarie.matthess@gtz.de

Management of Aquatic Resources and Fish Trade: Challenges for the German Development Cooperation

UWE SCHOLZ, PETER JARCHAU, KAI WIEGLER

German Agency for Technical Cooperation (GTZ), Division of Agriculture, Fisheries and Food, Germany

In 2004 about 37 % of the worldwide fish production of around 130 million tonnes went into the international fish trade. For many developing countries - being net importers of fish in 1985 - the trade of fish and fisheries products has become increasingly important for their economies: in 2004 they exported 29 million tonnes representing a trade value of around US$ 35 billion.
However, there is a danger that the dynamically growing demand for fish and fisheries products from developing countries can result in more even more pressure on often already over-utilised fish stocks and in the exclusion of small-scale fisheries (not only from trade and but also from fish resources). The small-scale fisheries, representing an important basis for food security and livelihood for many communities, are competing not only with the local industrial fishing vessels but often also with distant water fishing fleets of developed countries.
In the capture fisheries sector, challenges comprise among others the establishment of ecosystem-based fisheries, co-management systems of national, regional and international waters, the fight against subsidies to reduce overcapacity of fishing fleets and the fight against illegal, unreported and unregulated fishing; in the aquaculture sector, challenges are the integration of sustainable and eco-friendly smallholder aquaculture produc-tion systems, the sustainable supply of feeds and aquaculture technology and above all, for capture as well as farm fisheries, fair and equitable access to trade.
The authors give an overview on recent trends in world fisheries and aquaculture and present the potential fields of interventions/assistance for German Technical Cooperation.

Keywords: Aquaculture, capture fisheries sector, fisheries, trade

Contact Address: Uwe Scholz, German Agency for Technical Cooperation (GTZ), Division of Agriculture, Fisheries and Food, Eschborn, Germany, e-mail: uwe.scholz@gtz.de

Poverty Reduction and Pro-poor Growth: the German Development Cooperation Perspective and the Challenges for Agricultural Research

CLAUDIA KRAEMER

Federal Ministry for Economic Cooperation and Development (BMZ), Rural Development, Global Food Security, Germany

In many developing countries, agriculture is still the major employer and main source of both national income and export earnings. Therefore, growth of the agricultural sector promises direct poverty reduction effects. Additional effects of agricultural growth can be observed through lowering and stabilising food prices, and rising employment rates in rural areas, not only in agricultural production, but also in the areas of input-supply and post-harvest processing. For these reasons, the internationally agreed MDGs won't be achieved unless economic growth benefits the poor parts of the population. Rural areas and the needs of farmers and other stakeholders are diverse. To successfully address the needs of the rural poor, policies need to be adapted to these diverse contexts.

The institutional framework is one major bottleneck for agricultural growth and rural development. If the agricultural sector is to gain momentum again, strong institutions with the capacity to develop an appropriate blend of policies, regulatory frameworks and investments are essential. Extension and research services in particular have to be re-developed to deliver client-focused services based on a demand-driven rather than a supply-led approach. This is one major principle for the International Agricultural Research Centres which we support with significant contributions.

A changing global context and new demands for aid effectiveness and donor harmonisation have created challenges for German Development Cooperation, too. These will be highlighted by the following four presentations. The first will give an overview of the emerging new aid architecture, which is characterised by a more targeted use of development aid to heighten efficiency and avoid duplications. Fisheries contribute significantly to income generation and food security, but are threatened by incoherent international policies. Helping to avoid unsustainable practices is a challenge highlighted in the second presentation. The value chain approach and its linkages to agricultural research is subject of the third presentation, whereas the last one focuses on knowledge management and knowledge networks, with the Global Donor Platform for Rural Development being one promising example.

Keywords: Global donor platform, Millennium Development Goals (MDG), poverty reduction, Pro-poor growth

Contact Address: Claudia Kraemer, Federal Ministry for Economic Cooperation and Development (BMZ), Rural Development, Global Food Security, Germany, e-mail:

Conflicts, Challenges and Diversification

The „wrong“ Gender: Is Social Capital More Accessible to Men?

ELISABETH GOTSCHI[1], ROBERT DELVE[2], BERNHARD FREYER[1]

[1]*University of Natural Resources and Applied Life Sciences, Institute of Organic Farming, Austria*

[2]*International Centre for Tropical Agriculture (CIAT), Zimbabwe*

The creation of farmer groups has been a popular strategy in rural development to work with farmers in an organised way. Group organisation strengthens farmers' capacities to access information and markets and gives them a voice that is otherwise not heard. Being in a group allows people to increase their number of social relations, creates trust and other features of social capital. It has been argued that high levels of social capital can be transformed into financial capital.

Research in 20 agriculture-based groups in Búzi district in Mozambique revealed that gender is the key characteristic to human and social capital formation in rural areas. Although men and women equally participate in group activities, the benefits outcomes of social capital are significantly unequally distributed. Benefits of social capital were not equally distributed over members and varied significantly between gender, position and education. It was evident that men, group leaders and educated members are more likely to access help or credit, than women, members-only and people with little education. Women found it harder to benefit from the increased number of social relations or the trust created into benefits such as information, access to markets, or help in case of need. Whereas men are not restricted on a daily basis and are able to create and engage in more relations with group members or other people from the community and help others if they are asked to, thus increasing their social capital more quickly and strongly.

The contribution of women to food security has been widely acknowledged and gender sensitive approaches have been discussed for years in the development debate. Despite attempts to mainstream gender in development activities, there is still a lack of understanding in how to do so in planning, implementing and evaluating rural development projects. More systematic research is needed to fully understand the complexity of group dynamics in relation to culture and gender roles to address the different needs of gender groups and overcome existing cultural barriers.

Keywords: rural development, Mozambique, associations, gender, social capital

Contact Address: Elisabeth Gotschi, University of Natural Resources and Applied Life Sciences, Institute of Organic Farming, Gregor Mendel Strasse 33, Wien, Austria, e-mail: elisabeth.gotschi@gmx.at

Participatory Research That Builds on Local Innovation in Beekeeping to Escape Poverty

HAILU ARAYA[1], YOHANNES GEBREMICHAEL[2], ABERA GEBREAMLAK[3], ANN WATERS-BAYER[4]

[1]*Institute for Sustainable Development (ISD), Sustainable Community Development, Ethiopia*
[2]*Addis Ababa University, Geography, Ethiopia*
[3]*Tigray Bureau of Agriculture and Rural Development, Extension, Ethiopia*
[4]*ETC Foundation, ETC EcoCulture, Netherlands*

In Tigray Region in northern Ethiopia, many smallholders earn income by selling honey and bee colonies, which are highly demanded and expensive. This contributes importantly to household food security. To improve their beekeeping and their incomes, some farmers have been creative in developing own innovations, related primarily to beehive modification and queenbee rearing but also to honey separation and bee-forage selection.

As part of a multi-stakeholder research and development programme called PROFIEET (Promoting Farmer Innovation and Experimentation in Ethiopia), the Northern Typical Highlands Zone platform (Tigray Bureau of Agriculture, Tigray Agricultural Research Institute, Institute for Sustainable Development, Mekelle University, Adigrat Catholic Secretariat, Relief Society of Tigray, Bureaux of Water Resources and of Education) encourages identification and documentation of innovations developed by farmers. Numerous beekeeping-related innovations by men and women farmers were found. For example, they modify beehives by combining traits of the traditional and modern: making own versions of the top-bar beehive using wood, mud and dung. These are far cheaper than the purchased "modern" hives, insulate better against heat and cold, and bring higher yields.

The PROFIEET platform in Tigray is bringing beekeepers together to show and explain their innovations to each other and researchers and extension experts, and to develop ideas for joint experimentation in participatory innovation development (PID). At an agricultural exhibition held in March 2006 in Tigray's capital Mekelle, the identified beekeeping and other local innovations were presented alongside technologies from formal researchers.

This paper analyses the differentiated responses of farmers, researchers and experts to the innovations coming from farmers and from formal researchers and their respective concepts of intellectual property rights. The significance of such exchange fora and of the PID activities based on smallholders' innovations is analysed with a view to PROFIEET's efforts to institutionalise farmer-led PID within research, extension and education in Tigray as a means to reduce poverty, increase food security and encourage sustainable management of natural resources.

Keywords: dryland farming systems, endogenous livestock development, Ethiopia, articipatory research

Contact Address: Ann Waters-Bayer, ETC Foundation, ETC EcoCulture, POB 64, NL-3830 AB Leusden, Netherlands, e-mail: ann.waters-bayer@etcnl.nl

Utilizing Social Capital to Minimize Conflicts in Natural Resource Management and Use in Rural Communities in Eastern and Central Africa

MICHAEL WAITHAKA[1], ISAAC MINDE[2]

[1]*Association for Strengthening Agricultural Research in East and Central Africa (ASARECA), Uganda*

[2]*International Crops Research Institute for the Semi Arid Tropics (ICRISAT), Zimbabwe*

The use and management of natural resources in brittle ecosystems is susceptible to multiple forms of conflicts. This arises due to the fragile agro-ecological and social space characterised by the utilisation of natural resources for multiple purposes by multiple users which invoke complex and unequal relationships among a wide variety of social actors and stakeholders. Key players are pastoralists and sedentary farmers eking a living on fringes of national parks, forests and water bodies. Those areas have complex land tenure, ownership and use systems which raise conflicts between different communities. Conflicts lead to deforestation, destruction of crops, land degradation and displacement of people depriving many of their assets and livelihoods. The nexus between poverty, rural communities and natural resource management and use conflicts brings to the fore the fact that natural resources (land, water, forests) are the closest and weakest victims for the poor. Studies in Kenya, Tanzania and Uganda have addressed the nature, types and dimensions of natural resource management conflicts, and investigated mechanisms and procedures for minimising them. Measures to reduce conflicts suffer in the wake of lack of clear policy guidelines and weak institutional setups to enforce social order. Social capital is a potential least-cost means of addressing rural poverty which can be sustained at reasonable costs in a community. Lessons learned in building social capital in selected localities can be easily scaled up and out in other areas with minor adjustments based on existing economic, socio-cultural settings and agro-ecosystems. Efforts to minimise conflicts should revolve around the power and role of social capital in identifying, characterising and providing local solutions. Such efforts should strengthen processes of negotiation and encourage collective action to community conservation to address degradation. They should consider adjustment of customary norms and rules of land holding and access as opposed to outright replacement of customary tenure. They should put emphasis on use rights as opposed to ownership in order to secure rights access for the poor. For the marginalised poor, public investments in provision of water, health and education facilities are required.

Keywords: Conflict minimisation, east Africa , natural resource management, social capital

Contact Address: Michael Waithaka, Association for Strengthening Agricultural Research in East and Central Africa (ASARECA), Plot 13 John Babiiha Road, Entebbe, Uganda, e-mail: m.waithaka@asareca.org

Local Realities and Global Demands — a Case Study on Conflicts and Natural Resource Management in South West Burkina Faso

HERMANN KAMBIRÉ[1], MARIA BROCKHAUS[2]

[1]*Institut National des Etudes Recherches Agronomiques (INERA), Sociology, Burkina Faso*

[2]*Justus-Liebig-Universität Giessen, Institute of Agricultural Policy and Market Research, Germany*

In South West Burkina Faso conflicts between farmers and herders are a common phenomenon. These conflicts are influenced by factors which range from ecological and sociological to political causes. Local realities meet global demands (e.g. for political change, increasing agricultural productivity, change of production systems). Sustainable and equitable development is not always the outcome of these induced processes of change.

A six-month case study on conflicts, land use, and the management of natural resources was carried out in two villages in the provinces Noumbiel and Poni. Semi-structured interviews and focus group discussions were held with farmers, herders, local authorities and the formal institutions in the district.

The results show the different situation in the villages: cooperation and rather successful conflict management were predominant in one village. In the other, conflict escalation could be observed and out-migration of herders which were immigrated in the village in the last decade. Reasons can be seen in stronger competition between the user groups in one village, which was enforced by project activities like rice production in an area used as strategic water resource by the herders. Additionally, the integration of the herders ('latest-comers') in local decision making processes differed remarkably, as well as the perception by the herders of the bundle of rights they hold. Furthermore, the involvement of local elites varied, which followed a career in the capital. In one village the wish was expressed by them to defend the rights of the 'autochthonous', since a change in the current land tenure system and an upcoming land market was expected. In the other, emphasis was put on the opportunity of a win-win situation for both user groups by cooperation.

Induced global processes of change, implemented top-down, can aggravate a segregation in local 'first and last classes', and an exclusion of user groups, if different settings of the resource users in access to rights and degree of local citizenship are ignored by policy makers at national and global level.

Keywords: Burkina Faso, farmer-herder conflicts, natural resource management

Contact Address: Maria Brockhaus, Justus-Liebig-Universität Giessen, Institute of Agricultural Policy and Market Research, Senckenbergstraße 3, 35390 Gießen, Germany, e-mail: maria.brockhaus@agrar.uni-giessen.de

Role of Participatory Action Research in Reviving Endogenous Rangeland Management: A Case from Southern Ethiopia

GETACHEW GEBRU[1], SOLOMON DESTA[2], DADHI AMOSHA[1], LAYNE COPPOCK[3]

[1]*International Livestock Research Institute (ILRI), Global Livestock CRSP Pastoral Risk Management Project, Ethiopia*

[2]*Global Livestock CRSP Pastoral Risk Management Project, c/o International Livestock Research Institute, Kenya*

[3]*Utah State University, Dept. Environment & Society, United States*

African rangelands are extensive and support large populations of pastoral people and livestock. The semi-arid Borana Plateau is an especially important rangeland for Ethiopia. It is over 95,000-km^2 in size and home to about 350,000 people and one million head of cattle, small ruminants, and camels. The grazing systems of the Borana Plateau have become increasingly unsustainable in recent decades, however, because of human population growth, expansion of maize production in dry-season grazing areas, and range degradation in the form of woody encroachment. Heavy grazing by livestock, reduced mobility of pastoralists, and lack of fire have contributed to conversion of open, mixed savannah communities to dense woodlands and bushlands. Herbaceous forage production for cattle and sheep can then be reduced via competition with woody plants for water and light. Residual grass can be subjected to intense grazing pressure, further exacerbating the downward spiral. Prescribed fire is the most cost-effective means of manipulating vegetation in savannah ecosystems of eastern Africa. A blanket national ban on the use of fire was initiated in Ethiopia during the 1970s. This was intended to protect croplands and other natural resources from indiscriminant burning, but one unintended consequence of this policy has been a weakening of traditional forms of range management that depended, in part, on the regulated use of fire to control undesirable woody plants, promote herbaceous forage production, and reduce populations of disease-carrying ticks. Efforts by pastoral communities to revive endogenous range management practices like the use of fire are now gaining the positive attention of policy makers. An alliance among pastoral communities, researchers, policy makers, and development actors is being forged to re-introduce prescribed fire to the Borana Plateau. Describing this process is the objective of this paper. The process requires a combination of indigenous knowledge, modern technology, training, and research, as well as creation of a truly collaborative management approach. Rather than top-down research, the key elements for change have been participatory action research, outreach, and engagement with a wide variety of stakeholders.

Keywords: Borana Plateau, collaborative problem solving, indigenous knowledge, pastoral development , prescribed fire, savannah ecosystems

Contact Address: Layne Coppock, Utah State University, Dept. Environment & Society, 84322-5215 Logan, UT, United States, e-mail: Lcoppock@cc.usu.edu

Livelihood, Education and Development

Science for Development — Policy Broker or Ivory Tower ?

MARIA BROCKHAUS

Justus-Liebig-Universität Giessen, Institute of Agricultural Policy and Market Research, Germany

Policy-making is a complex process influenced by a multitude of factors and effects which are not always transparent, and is executed by policy-makers which do not always act rationally. Following the concept of evidence-based policy making, science and research (S&R) should inform policy-makers in such a way that the process of policy-making is rational, rather than opinion-based (Sutcliffe, Court 2006; Davies 2004).

However, the existence of evidence alone is not a guarantee that it will inform policy-makers, as shown by today's realities in developing (as well as in developed) countries. Besides fulfiling quality standards such as credibility, problem specificity, solution orientation, and communicability, the given evidence has to be placed into the policy process which consequently, demands more action on the side of S&R institutions. Often, it lacks of formal or informal information channels and linkages between S&R institutions at national and international levels, and with other actors in the policy arena. Additionally, existing linkages are not fully used.

This paper presents network analysis as a tool to identify relevant actors, and the existing or missing paths and channels among them. It uses a case study in Burkina Faso as an example and examines the reasons for success and failure in efforts for evidence-based policy making. The analysis is based on results of a two-year research on policy networks in Burkina Faso (2001–2003).

In particular, the role of an independent agricultural research network (focusing on land policy) will be examined. Its role as a policy broker in the arena of natural resource management indicates the importance of active networking to communicate scientific evidence, even though manifold obstacles are present, and the potential of such organisations is still not fully used.

The results show that network analysis can be a useful tool to support S&R's role (and responsibility) as a policy broker to avoid inaccessible ivory towers full of evidence.

Keywords: Burkina Faso, evidence-based policy making, natural resource management, network analysis, policy analysis, policy broker, Science & Research

Contact Address: Maria Brockhaus, Justus-Liebig-Universität Giessen, Institute of Agricultural Policy and Market Research, Senckenbergstraße 3, 35390 Gießen, Germany, e-mail: maria.brockhaus@agrar.uni-giessen.de

DAAD and its Challenges for Capacity Building

HANNS SYLVESTER[1], CAY ETZOLD[2]

[1]*German Academic Exchange Service (DAAD), Head of Development Co-operation Division, Germany*

[2]*German Academic Exchange Service, Head of Section 432 - Alumni and Partnership Programmes, Germany*

Prosperity and Poverty in a Globalized World — Challenges for Agricultural Research– Considering the Tropentag's topic and its aims, i.e. an exchange concerning the following questions: How to improve livelihood, health and education of the rural population? How to reduce pressure on the environment caused by agricultural production? How to balance the production of sufficient, high quality food for an increasing world population? Which new approaches do exist to optimise the utilisation of scarce resources (soil, energy, water)? Then the emphasis laid on the exchange of information within the scope of the Tropentag also becomes obvious: The importance of the exchange of knowledge and experience as well as interdisciplinary, scientific discussions on global challenges.

The DAAD also aims at these objectives: The exchange of knowledge and experience is elementary for facing today's global challenges.

The German Academic Exchange Service promotes the worldwide co-operation and exchange between institutions of higher education as well as between these institutions and politics and economy, particularly the co-operation with developing countries.

Therefore, the DAAD's instruments of promotion shall be elucidated, as they serve for reducing poverty, for peacekeeping and for a juster design of globalisation.

By means of education and advanced education of specialists and executives as well as the selective set-up of academic structures, crucial suppositions for achieving the Millennium Development Goals are created.

Thereby, Development in Partnership is very important to warrant a sustainable development. Particularly the formation of networks for future measures offers an enormous advantage. In this context, the topic of the Alumni Networks will be treated, whose fusions on regional and sectoral levels aim at realising common projects in different disciplines.

Keywords: Alumni Networks, Development in Partnership, instruments of Promotion

Contact Address: Hanns Sylvester, German Academic Exchange Service (DAAD), Head of Development Co-operation Division, Kennedyallee 50, 53175 Bonn, Germany, e-mail: Sylvester@daad.de

From Knowledge to Action - Presentation of Curricula Modules for a Stronger Implementation Focus in Tropical and Development Research

PETER MOLL

Science Development, Germany

Tropical research has been evaluated lately by DAAD, BMZ and others and requested to develop stronger application and implementation elements in university and higher education curricula. Many curricula in Germany are of high quality on academic grounds but, in international comparison, sometimes lack teaching on possible practical implementation. To provide qualification for new job profiles is not everywhere very high on the agenda. The move from foremost scientific knowledge generation to a stronger implementation outlook means a challenge for higher education that is becoming ever more topical with changes in the university education and diploma infrastructure and with increasing emphasis on M.Scs and MAs as respected university degrees. It is not the theoretical components themselves nor the practical - e. g. field experience - components of teaching alone that present this challenge. The real challenge lies in steps towards “management of the interface”. That is, curricula need to include ever stronger elements that prepare students for real world applications of the acquired knowledge. This involves managerial and communicative as well as social and cultural “techniques” for dealing with stakeholders and interest groups. It involves teaching on social, economic and political frameworks for development work. And it involves teaching for science management and project management, that can prepare absolvees to work in large international science networks and prorammes funded e. g. by the Worldbank, GEF or UNEP. The presentation is on ways on HOW to possibly extend existing curricula and on how to integrate stronger application and implementation elements in tropical research. These modules have been developed on the basis of a 2 year monitoring and research project funded by BMBF. During this project some 70 experts have been consulted and projects dealing e.g. with land use problems in Africa or biodiversity loss in South America have been investigated. Particularly in the anglo-saxon academia (USA, GB, Canada) university curricula have been developed lately that go beyond mere academic interdisciplinarity and integrate stronger implementation elements. The presentation will provide an introduction into this development and some suggestions for action.

Keywords: Curriculum development, from knowledge to action, implementation focus of tropical / development research

Contact Address: Peter Moll, Science Development, Viktoriastr. 49, 42105 Wuppertal, Germany, e-mail: moll@science-development.de

Assessment of the Impacts of Natural Resource Management Research in the CGIAR

HERMANN WAIBEL[1], DAVID ZILBERMAN[2], TIMOTHY KELLEY[3]

[1]*Leibniz-University Hannover, Development and Agricultural Economics, Faculty of Economics and Management, Germany*
[2]*University of Berkeley, Agricultural and Resource Economics,*
[3]*Food and Agriculture Organisation, Sustainable Development Department,*

During the past decade, research and development activities in natural resources management (NRM) has been intensified. Among the CGIAR Centres investments in NRM research have increased substantially both within the older commodity-oriented Centers and the newer resource management Centers. However, until recently there is lack of convincing evidence on the impact of NRM research that could justify the roughly 20 % of the CGIAR budget allocation for NRM.
The paper presents a synthesis of the results and summarises the lessons learned of an initiative undertaken by the CGIAR's Science Council's Standing Panel on Impact Assessment (SPIA) to assess the impacts of past investments in natural resources management research (NRMR) in the CGIAR System. In total there were seven impact assessment case studies from the following CGIAR Centres: CIAT, CIFOR, CIMMYT, ICARDA, ICRAF, IWMI and WorldFish Center. The studies covered a range of geographical regions, with two projects in Sub Saharan Africa, one in North Africa, two in Asia and one projects with global coverage. The projects also include different types of NRM innovations including both micro and macro projects.
The paper analyses the case study results by assessing the rates of return to this type of research and comparing NRM to the more popular germplasm enhancement research. It can be shown that investment in NRM research is economical but seldom reaches the high rates of return found for breeding. An assessment of the kind of impacts usually not included in the rate of return of NRM research investments is provided. The paper also lays out the direction of expansion of existing methods to meet the needs of assessing the impacts of NRM research projects and identifies the new direction of methodologies to accommodate unique features of NRM research. Measures and indicators of impact and some basic issues arising from the nature of NRM research are discussed. Finally, some practical recommendations regarding the further conduct of NRM impact assessment are submitted.

Keywords: CGIAR, Impact Assessment, natural Resource Management, Rates of Return

Contact Address: Hermann Waibel, Leibniz-University Hannover, Development and Agricultural Economics, Faculty of Economics and Management, Königsworther Platz 1, 30167 Hannover, Germany, e-mail: waibel@ifgb.uni-hannover.de

E-learning for Agricultural Communities

AGATA MONIKA JAGODA

Humboldt-Universität zu Berlin, Department of Agriculture and Horticulture, Germany

Agricultural knowledge and new technologies of food production often do not reach the ultimate users: the farmers. E-learning transmits relevant information to farmers and educators, thus contributing to higher education and poverty alleviation. E-learning is seen as a means of increasing access to educational opportunities in rural areas and keeping pace with rapid changes within the agricultural sector. This study examines e-learning adoption trends within the agricultural producer community in Central-Java, Indonesia. Whereas e-learning has reached early or late adoption status within other sectors, such as in the IT sector, Economy and Management, Indonesian Agri-Business have yet to "jump on board". Numerous reasons were noted, including: rising cost of traditional, classroom-based training, long distances from peripheral regions to centres for education, lack of teachers for agricultural production, internet and computer access in Central-Java, wide spread Mobile telephony in the rural areas, computer skills for Indonesian farmers, low production costs for e-learning, and sustainability of e-Learning courses for Agri-Business. The study did note various agricultural e-learning initiatives of online university courses and programs. Specific objectives of the project are to: (1) train interested farmers, agricultural researchers, educators in the production and use of e-learning courses, (2) Produce e-learning materials on agricultural production methods, (3) introduce the materials in selected communities, (4) support their technical delivery and provide the hardware. The production of desirable e-learning courses with free ware Content Management Systems (CMS) and the written survey would be published and of interest to regional government, e-learning developers and agricultural producers. The author set out to understand e-learning adoption trends, barriers and opportunities within Indonesian agricultural sector. The study will also examine potential benefits of e-learning to the agricultural sector. Opportunities are noted, along with best practices to assist those who wish to develop e-learning products and services for this sector.

Keywords: CMS, e-learning, education, free ware

Contact Address: Agata Monika Jagoda, Humboldt-Universität zu Berlin, Department of Agriculture and Horticulture, Mareschstr. 9, 12055 Berlin, Germany, e-mail: info@mathe-agrar.de

Determinants of Successful Participation of Poor Farm Households in Transferring Advanced Agricultural Technologies - Case Study from the Mountainous Region of Northern Vietnam

HIEN DINH PHAM

University of Hohenheim, Institut für Agrar und Sozialökonomie in Den Tropen und Subtropen, Germany

In the mountainous regions of Vietnam, advanced technologies are playing an important role in both increasing the income and reducing poverty for farm households. Cho Don district is a typical mountainous district of Bac Kan province with diversified ethnic minority groups and a significant potential for crop and livestock production as well as forest exploitation. The district enjoys many transfer programs of advanced technologies in agriculture and those programs have been implemented very early. Advanced technologies have the potential of helping farm households to increase their income, knowledge and skills as well as to reduce poverty. Interestingly, the poverty rate has gradually come down in the last years. This paper mainly aims at determining the positive and negative factors that have been affecting the participation of farm households, communities and other relevant stakeholders in the transfer of advanced technologies in agriculture. The logit model and advanced technologies participation model are used to identify those factors. The analysis helps to improve and promote the technology acceptance, participation and poverty alleviation process more successfully and sustainably. The data of this analysis have two sources: primary data and secondary data collected in Cho Don district in 2004. We found that advanced technologies transferred came from four channels, namely: Government Extension Programs, Research Institutes, Foreign Aid Organisations and Non-Governmental Organisations (NGOs). Those bring large benefits for farm households and communities. However, advanced technologies in agriculture are still not efficiently and sustainably accepted because of participation's insufficient involvement of farm households (especially the poor households) and shortage of farm households as well as communities' contribution. In addition, those advanced technologies have not adequately met the real needs of farm households and communities.

Keywords: Advanced technology, participation, transfer

Contact Address: Hien Dinh Pham, University of Hohenheim, Institut für Agrar und Sozialökonomie in Den Tropen und Subtropen, Stuttgart, Germany, e-mail: dphamhien@yahoo.com

Plants and Soils

Plant Production Systems

Spatial Variability of Crop Growth as Affected by Contour Hedgerow Systems

WANWISA PANSAK[1], THOMAS HILGER[1], GERD DERCON[2], THANUCHAI KONGKAEW[3], GEORG CADISCH[3]

[1]*University of Hohenheim, Plant Production in the Tropics and Subtropics, Germany*

[2]*University of Hohenheim, Institute of Plant Production and Agroecology in the Tropics and Subtropics, Germany*

[3]*Naresuan University, Department of Agricultural Science, Thailand*

In the tropics, soil conservation measures to control water induced erosion have been intensively investigated in the past decades. Land management techniques such as contour hedgerow systems are very effective in erosion control but they also may lead to a pronounced spatial variability in crop response. However, our understanding of this phenomenon at field scale is limited. This study aimed, therefore, at assessing the spatial variability in crop response under contour hedgerow systems. Data were collected from an erosion control experiment in the Loei province of Northeast Thailand established in 2003. The trial was set up on a clayey, kaolinitic, typic Haplustalf in a split plot design with five maize cropping systems as main plots and two fertiliser levels (no fertiliser and 61 and 13.9 kg ha^{-1} of N and P) as sub-plots. Slope gradients ranged from 21–28 %. From these treatments, farmer's practice, mango-grass hedgerows, and leucaena hedgerows, each at both fertiliser levels, were selected to conduct this study. Maize grain yields, aboveground vegetative biomass, harvest index and height were determined per row and related to their transect position in each plot. A simple index was used to assess the effect of contour hedgerows on crop response, indicating that contour hedgerow systems cannot always be evaluated as completely positive. The impact of contour hedges on maize growth in rows adjacent to the contour hedgerow was strong. Negative effects on crop growth, however, were stronger in the upper part of the alleys and in the mango-grass treatment. Soil fertility improvement on the upper part of the alleys and a better management of the barrier strip may enhance crop productivity.

Keywords: Contour hedgerows, crop response index, Leucaena, maize, mango, ruzi grass, spatial variability

Contact Address: Thomas Hilger, University of Hohenheim, Plant Production in the Tropics and Subtropics, Garbenstr. 13, 70593 Stuttgart, Germany, e-mail: t-hilger@uni-hohenheim.de

The Functional Assessment of Tree Windbreaks in Khorezm, Uzbekistan, Aral Sea Basin

ALEXANDER TUPITSA[1], JOHN LAMERS[1], MARTIN WORBES[2], CHRISTOPHER MARTIUS[1]

[1]*University of Bonn, Center for Development Research (ZEF), Germany*

[2]*Georg-August-Universität Göttingen, Institute of Agronomy in the Tropics, Germany*

In Uzbekistan, over 50 % of farmland suffers from wind erosion; about 80 t/ha of topsoil are lost to wind each year. Winds also decrease land surface humidity, scatter seeds and sandblast fields. Windbreaks positively affect microclimatic change, and protect neighbouring fields. Strong winds can lose about 50–80 % of their velocity passing through optimally designed tree strips. Consequently, air humidity raises 3–20 % while the air temperature drops by two-three degrees Celsius allowing for yield increases by 10–20 %. In 1966–1992, tree windbreaks were planted on about 40,000 ha of agricultural land in Uzbekistan. After 1992, this practice almost completely ceased, due to a change in priority setting after Uzbek independence. Today, many old windbreaks are cut down or die due to a lack of care. Well-designed and maintained windbreaks to combat erosion need to be re-established. First an inventory was conducted using remote sensing techniques on the occurrence and structure of tree windbreaks along two transects in Khorezm, a region in Uzbekistan closely located to the Aral Sea. We identified more than 2300 tree strips stretching over a total of 700 km in the cropland area of 39 thousand hectares of these two transects. The land covered with tree strips amounted to 450 ha (about 1 %) which is lower than the nationally recommended minimum of 1.5 %. We analysed these windbreaks based on recommendations for an optimal windbreak design. Results showed that:

• Monospecific mulberry strips (*Morus spp.*) comprised 50 % of windbreaks;

• Only 70 % of the windbreaks were oriented in the NS and NW-SE directions, the desirable direction since the highest speeds (>3 m/s) are generally prevailing from E and NE;

• The majority of the investigated tree strips did not satisfy the minimal height of 5 m; other structural criteria like stand porosity, length and width had acceptable values.

This study revealed the existence of numerous windbreaks in a dryland region where generally trees are not expected; however, their structure and layout must be improved to gain the expected efficiency and can contribute to combat an advancing land degradation.

Keywords: Assessment, farmlands, remote sensing , wind erosion, windbreaks

Contact Address: Alexander Tupitsa, University of Bonn, Center for Development Research (ZEF), Walter-Flex-Str. 3, 53113 Bonn, Germany, e-mail: atupitsa@uni-bonn.de

Cultivation Site Dependent Variations of Forage Yield and Quality of Tropical Shrub Legumes

TASSILO TIEMANN[1], MICHAEL KREUZER[1], CARLOS LASCANO[2], HANS-DIETER HESS[3]

[1]*ETH Zurich, Institute of Animal Science, Switzerland*

[2]*Centro Internacional de Agricultura Tropical (CIAT), Colombia*

[3]*Agroscope Liebefeld-Posieux, Swiss Federal Research Station for Animal Production and Dairy Products (ALP), Switzerland*

Ruminants play an important role as assets and sources of high quality food and income for the rural population in developing countries. Their productivity is often limited due to low protein supply owing to the limited availability of good quality forages, particularly in regions with a prolonged dry season and soils of low fertility. As part of an extensive search for forage shrub legumes that would meet the requirements as forage plants and perform well on low-fertility soils, a series of in vitro-experiments and agronomic evaluations were conducted. Five particularly promising legume species were tested in these experiments (*Calliandra calothyrsus*, *Cratylia argentea*, *Desmodium velutinum*, *Flemingia macrophylla*, *Leucaena leucocephala*). The results showed that the cultivation site may have an important influence on the forage quality of legumes, particularly for species containing condensed tannins (CT). In vitro-experiments with *Calliandra calothyrsus* showed differences in the tannin content and the degradability of nutrients, particularly of crude protein (CP), dependent on the cultivation site. Plants cultivated on more fertile soils had clearly lower CT contents than those on low-fertility soils. Apparent CP degradability of diets supplemented with *C. calothyrsus* from more fertile soils was approximately 30 % higher ($p < 0.001$) than CP degradability of diets containing the same species cultivated on low-fertility soils. The agronomic evaluation revealed large variations in the adaptability of the different shrub legume species to acidic low-fertility soils and their response to fertilisation. While *Flemingia macrophylla* did not show any differences in biomass production due to soil type, the other species produced two to three times more biomass on the more fertile soil. Fertiliser application affected all species in terms of biomass production and leaf proportion but the extent of the response varied widely among species. Overall, these experiments showed a high impact of planting site on forage quality and yield and indicate that strong interactions between legume species and soil fertility may occur. These finding are of particular interest for future extension work, aiming at promoting legume-based feeding technologies.

Keywords: Legumes, protein, ruminants, tannins, tropical forages

Contact Address: Hans-Dieter Hess, Agroscope Liebefeld-Posieux, Swiss Federal Research Station for Animal Production and Dairy Products (ALP), Route de la Tioleyre 4, CH-1725 Posieux, Switzerland, e-mail: dieter.hess@alp.admin.ch

Germplasm Movement of Selected Underutilised Multipurpose Tree Species in Sri Lanka

BORIS M. HILLMANN[1], HANNAH JAENICKE[2], BRIGITTE L. MAASS[1]

[1]*Georg-August-University Göttingen, Department of Crop Sciences, Agronomy in the Tropics, Germany*

[2]*International Centre for Underutilised Crops, Sri Lanka*

Multipurpose trees play an important role for the livelihoods of rural and urban people in the tropics. Several species are typical components of homegardens. These species are mainly unimproved landraces. Tree improvement is a slow process because of the long time to flowering and fruiting. The International Centre for Underutilised Crops (ICUC), Colombo, Sri Lanka is studying the value of selected underutilised fruit tree species for income generation of small-scale entrepreneurs. In this study, jackfruit (*Artocarpus heterophyllus* Lamk.), bael (*Aegle marmelos* (L.) Correa) and four different *Annona* species were surveyed. Although some improvement research has been done with jackfruit, improved planting material seems still confined to nurseries. No formal improvement activities appear to have been undertaken for either bael or the *Annona* species. Overall, little is known about the provenance and quality of planting material used in farms and whether or how improved lines find their way to the user. This work mainly aims to understand the diversity of sources of planting material found in homegardens and, consequently, describe germplasm flow. For the study, two locations of Sri Lanka were selected where ICUC is active: Kandy and Galle. Semi-structured interviews of 30 farmers and about 10 nursery operators per location were conducted. Differences between locations were established by applying several diversity indices (Sørensen's coefficient, Shannon's and Simpson's indices). The germplasm movement for the selected species seemed to be very weakly developed. Additionally, farmers were not aware of the importance of improved varieties. The results of this study indicate not only the need for research and development in these underutilised multipurpose trees but also for more effective dissemination activities.

Keywords: *Aegle marmelos*, agroforestry, *Annona*, *Artocarpus heterophyllus*, genetic resources, germplasm movement, homegarden, multipurpose trees, Sri Lanka, underutilised crops

Contact Address: Brigitte L. Maass, Georg-August-University Göttingen, Department of Crop Sciences, Grisebachstr. 6, 37077 Göttingen, Germany, e-mail: bmaass@gwdg.de

Multi-period Analysis of Bt-cotton Varieties in China - Using Farm Level Panel Data

LIFENG WU[1], MARC VÖLKER[2], DIEMUTH PEMSL[3], HERMANN WAIBEL[2]

[1]*University of Hannover, Agriculture, Environment and Development, Faculty of Economics and Business Administration, Germany*

[2]*University of Hannover, Development and Agricultural Economics, Germany*

[3]*WorldFish Center, Policy, Economics, and Social Sciences, Malaysia*

Previous studies of Bt-cotton adoption in China have reported high farm level benefits. However, there is evidence that the farmers continue to use high levels of pesticides in spite of the adoption of bollworm resistant transgenic Bt-cotton. Most of these studies relied on cross section farm level data comparing adopters and non-adopters. In the present study we aim to contribute to a better understanding of the role of the insect resistance trait in Bt-varieties in productivity and profitability of small-scale cotton farmers. The analysis is based on panel data collected in 2002 and 2005 from some 150 farmers in five villages in Linqing County, Shandong Province, East China. Since Bt-cotton varieties account for 100 % of all the cotton planted in the research area, its impact cannot be captured by an adopter non-adopter comparison. Instead, the toxin concentration of Bt-plants has been used as a variable to measure the effect of the new varieties on bollworm control. A two-period production function following the damage control concept was estimated using an instrumental variable approach. Results allow assessing the productivity and profitability effect of the Bt-trait and chemical pesticides. Cotton production activities of farmers in the panel were monitored season long and data on inputs and outputs were recorded. In addition, in order to quantitatively capture the Bt-trait in cotton varieties, cotton leaves from each of the monitored fields were sampled and tested for Bt-toxin concentration. Results indicate that overuse of pesticides continues to exist in spite of 100 % Bt-cotton variety adoption. A possible reason is that the variation in Bt quality is high and farmers are faced with considerable uncertainty of their control effectiveness. Hence, farmers still use many sprays targeting cotton bollworm. At the same time, the effectiveness of pesticides is limited largely due to a similar problem with quality control. The uncertainty inherent in the key determinants of the productivity of pest control inputs calls for an integrated analytical framework that combines ecological and economic factors.

Keywords: Bt-cotton, China, damage control, panel data

Contact Address: Lifeng Wu, University of Hannover, Agriculture, Environment and Development, Faculty of Economics and Business Administration, Germany, e-mail: wwllff@sohu.com

Plant Nutrition and Soils

Understanding Farmers' Epistemology of Soil Fertility for an Appropriate Communication of the Concept of Integrated Soil Fertility Management: Empirical Evidence from Southern Bénin Republic

GUY-ERICK AKOUÈGNON[1], VOLKER HOFFMANN[1], RAINER SCHULTZE-KRAFT[2]

[1]*University of Hohenheim, Department of Agricultural Communication and Extension (430a), Germany*

[2]*University of Hohenheim, Department of Biodiversity and Land Rehabilitation, Germany*

There is a general consensus on the necessity of applying both organic and mineral fertilisers to sustain nutrient flow in low-input farming systems of densely populated areas of sub-Saharan Africa. The successful dissemination of this knowledge requires at village level the pre-identification of the factors susceptible to drive or to impede its implementation. At farmers' level, the most basic prerequisite for the successful communication of the message is to understand the target group's own definition of soil fertility and the strategies locally perceived as appropriate to build soil fertility.

In this study the concept epistemology of soil fertility is used to describe the meta-aspect of local soil knowledge which is beyond the ethnopedological elicitation and scientific validation of local soil categories. It rather seeks the meta-knowledge governing the local distinction of soil fertility and management strategies in different categories as a more generic frame to insert the "new" concept of soil fertility.

In four selected villages in Southern Bénin, the descriptors of different soil fertility categories and fertilising strategies were elicited. Through the step-wise generalisation procedure of induction, the spatial and temporal variability of the different soil and management categories are reduced to an overarching rule reflecting the frame of reference for local definition of soil fertility and management. In two villages the concept of soil fertility was found limited to the ability of a field to sustain maize growth without mineral fertiliser. The use of legume residues is prioritised but only on soils that are loosing fertility. Infertile soils are qualified as dead. An extension message is designed to translate the concept of integrated soil fertility and its missing notions. In the two other villages there was no field differentiation and variability in management strategies. Mineral fertiliser or the systematic combination of mineral fertiliser and manure are uniformly used. Correspondingly the feasibility of integrated soil fertility management and measures to support farmers' strategies are discussed.

Keywords: Knowledge dissemination, Integrated soil fertility management, local soil knowledge

Contact Address: Guy-Erick Akouègnon, University of Hohenheim, Department of Agricultural Communication and Extension (430a), Schloss Museumsflügel, 70593 Stuttgart, Germany, e-mail: guyerick@uni-hohenheim.de

Impact of Residue Decomposition and Nutrient Release on Soil Enzyme Activity and Nutrient Turnover in Soils in the Humid Tropical Lowlands of Cameroon

JULIA DUX[1], LINDSEY NORGROVE[2], BARBARA WICK[3], RONALD F. KÜHNE[4]

[1]*Institute of Vegetable and Ornamental Crops, Germany*
[2]*University of Hohenheim, Biodiversity and Land Rehabilitation in the Tropics and Subtropics,*
[3]*Humboldt-University Berlin, Division of Soil Science and Site Science, Germany*
[4]*Georg-August-Universität Göttingen, Institute for Plant and Animal Production in the Tropics, Germany*

We studied the impact of leaf residue decomposition and nutrient release of two weed / fallow species - *Imperata cylindrica* and *Chromolaena odorata* — and one pioneer tree — *Phyllanthus discoideus* - on enzyme activity and nutrient turnover in soils in the humid tropical lowlands of southern Cameroon in a pot experiment. We tested **(i)** the impact of litter types on decomposition rate, nutrient release and enzyme activities in soil, and **(ii)** whether soils from different vegetation and land uses differed in their ability to support decomposition under controlled conditions. We measured mass loss, nutrient release of N and P from decomposing residues, and soil enzymes of the C cycle (ß-glucosidase), N cycle (protease) and P cycle (acid and alkaline phosphatase) over 120 days.

Faster decomposition of *Phyllanthus* and *Chromolaena* residues and greater release of nutrients of N and P from decomposing leaves compared to *imperata* residues concurred with differences in residue quality. After 120 days, *Chromolaena* and *Phyllanthus* residue had released nearly three times as much of its initial pools of N and P than had *Imperata* residue. However, rapid recycling of N and P from *Imperata* residues in the early stages of decomposition increases the risk of nutrients being lost from the topsoil without contributing to SOM build-up in the long-term.

Most of the variation in ß-glucosidase activity was associated with differences among residue types. Decomposition and mass loss from the plant residue triggered C mineralisation in soils and were matched by equivalent increases in ß-glucosidase activity. By contrast, litter type had no impact on activities of alkaline phosphatase and protease. The role of N and P supply in regulating activity of enzymes that mineralise N and P differed for both nutrients. Protease was more responsive to variations in N supply than were P mineralising enzymes to P supply. Increases in residue nutrient fluxes of P associated with residue decomposition were not related to acid and alkaline phosphatase activity but was positively related to protease activity.

Keywords: Resiude decomposition, soil enzyme activity, weed infestation

Contact Address: Barbara Wick, Humboldt-University Berlin, Division of Soil Science and Site Science, Invalidenstraße 42, 10115 Berlin, Germany, e-mail: barbara.wick@agrar.hu-berlin.de

Exploring the Potential for Recycling Nutrients from Waste Water to Enhance Agricultural Productivity — the Example of Valley View University in Accra, Ghana

JÖRN GERMER, JOACHIM SAUERBORN

University of Hohenheim, Stuttgart, Institute for Plant Production and Agroecology in the Tropics and Subtropics, Germany

Agriculture in many countries of the developing world suffers from soil nutrient depletion with a directly associated reduction in yield. Contrariwise the rising population produces increasing amounts of organic human wastes derived from the food cycle. These wastes contain valuable nutrients which are withdrawn and not returned to the arable land instead they contaminate natural ecosystems. Use of human excreta and waste water for crop production could improve sustainability of agricultural systems through an increased emphasis on recycling and greater return of nutrients and water. At the Valley View University alternative sanitation and waste water technologies are installed which collect greywater and urine to boost crop production. Greywater from showers and sinks is used to irrigate crops like papaya (*Carica papaya*), banana (Musa × paradisiaca), plantain and cassava (*Manihot esculenta*), while urine collected from dry urinals is deployed to fertilise cereals. A mixture of urine and water derived from separating toilets is applied to mango (*Mangifera indica*) and cashew (*Anacardium occidentale*). The performance of all crops is closely monitored with the goal of optimal adaptation of the sanitary and collection facilities to local conditions and to investigate the nutrient and water cycling efficiency. Parallel the acceptability by the local people is assessed and pathogen monitoring programme is in place to guarantee hygienic safety. The nutrient efficiency of pure urine is studied in comparison with control, compound fertiliser, compound fertiliser plus water, compost and chicken manure in 6*5 block design field trial planted to maize. The nutrient supply is based on the application of NPK 15:15:15 compound fertiliser at a rate 667 kg ha^{-1} supplying 100 kg N, 44 kg P and 83 kg K per hectare. Urine, manure and compost are adjusted by the addition of TSP, KCl and Urea to provide the same amount of N, P and K. Preliminary results indicate that all nutrient sources increase the production drastically. With the aim to assess long term changes in soil fertility and to integrate the impact of low and highly variable precipitation, this trial will be continued for several years.

Keywords: Ecological sanitation, greywater, nutrient efficiency, urine

Contact Address: Jörn Germer, University of Hohenheim, Stuttgart, Institute for Plant Production and Agroecology in the Tropics and Subtropics, Garbenstr. 13, 70593 Stuttgart, Germany, e-mail: jgermer@uni-hohenheim.de

Soil Temperatures During Burning of Large Amounts of Wood in a Humid Forest Agro-eco System: Effects on Soil pH and Subsequent Maize Yields

STEFAN HAUSER

International Institute of Tropical Agriculture, Humid Forest Eco-regional Center, Cameroon

Slash and burn agriculture is still the dominant form of food production in the humid and sub-humid tropics of Africa, Asia and South America. In large parts of the Congo basin secondary and primary forest is cleared for particular crops. Little information is available on the temperatures attained during burning and the immediate changes of soil chemical properties. Soil temperature was measured during, and soil pH changes after burning 1000, 3000 and 5000 Mg ha^{-1} of wood, representing fuel loads of a range of tree boles commonly felled and burned for land preparation on southern Cameroonian Ultisols and Oxisols. During the burning of 1000, 3000 and 5000 Mg ha^{-1} of wood, the mean temperature at the soil surface reached 770°C and 214°C at 5 cm depth, without differences between fuel loads. At 10 cm depth the soil temperature was higher under 3000 (173°C) and 5000 (208°C) Mg ha^{-1} fuel loads than under 1000 Mg ha^{-1} (133°C). At 20 cm depth the temperature was higher under 5000 Mg ha^{-1} fuel load (163°C) than under 1000 (52°C) and 3000 Mg ha^{-1} (105°C). At 30 cm depth no differences were found (32 to 68°C). Burning of 10 Mg ha^{-1}, representing the natural regrowth of two years fallow on deforested land, caused no discernable temperature increases at any depth. At 24 hours after ignition, soil under 10 Mg ha^{-1} fuel load was at ambient temperature. At 3, 5, 10, and 12 cm depth temperatures were different between all fuel loads. At the surface the difference between 10 and 1000 Mg ha^{-1} fuel load was not significant, all others were.

Soil pH in 0–5 cm depth, increased within 9 days after burning (DAB) from 6.5 to 8.0 under 1000, 3000, and 5000 Mg ha^{-1} fuel load. Under 3000, and 5000 Mg ha^{-1} fuel load the pH continued to increase until 37 DAB, reaching 9.25. The pattern of pH with soil depth did not change between 37 and 79 days after burning.

Maize yields were significantly reduced when planted immediately after burning of 3000 and 5000 Mg ha^{-1} of wood, mainly due to low crop establishment.

Keywords: Cameroon, maize, slash and burn, soil pH, soil temperature, Ultisol

Contact Address: Stefan Hauser, International Institute of Tropical Agriculture, Humid Forest Eco-regional Center, Cameroon, e-mail: s.hauser@cgiar.org

Reaggregation of Secondary Grassland Top Soils in the South African Highveld: A Chronosequence Study

RAIMUND KÖSTERS[1], ANNE PREGER[1], CHRIS DU PREEZ[2], SONJA BRODOWSKI[1], WULF AMELUNG[1]

[1]*University of Bonn, Institute of Crop Science and Resource Conservation, Division of Soil Science, Germany*

[2]*University of the Free State, Department of Soil, Crop and Climate Sciences, South Africa*

Prolonged arable cropping in subtropical sandy grassland soils results in substantial losses of water-stable aggregates. This accelerates turnover of soil organic matter, leads to substantial soil organic matter losses and facilitates erosion. We hypothesised that restoration of these grassland ecosystems must involve the re-establishment of soil structure. To test this supposition we sampled chronosequences of degraded arable land (more than 20 years of cropping) that had been converted to secondary pastures between 1 and 52 years before present in three agro-ecosystems of the South African Highveld. Primary grasslands in the savannah also used as pastures served as controls. Arable land top soil was sampled for comparison. Samples from the surface soils (Plinthusthalfs; 0–10 cm) were fractionated according to aggregate size by wet sieving (8000–2800 μm, 2800–2000 μm, 2000–500 μm, 250–500 μm, 250–53 μm and $< 53\,\mu$m). All fractions were analysed for their respective content of soil organic carbon and total nitrogen and corrected for sand content. The first results show that reconversion of arable land into pasture does indeed recover parts of the soil organic carbon and nitrogen in these soils, which is accompanied by at least partial reaggregation. Ongoing analyses are evaluated to elucidate to which extent the restoration of soil organic matter and aggregation in the secondary grassland is possible in the three agro-ecosystems in comparison to the primary grasslands. Nevertheless, it can already be stated by now that the original state of the primary grassland is not easily reached, thus rising the question whether at least some of the former ecosystem services maybe lost irreversibly upon land degradation within post-industrial timescales.

Keywords: Land use change, secondary grassland, soil aggregation, soil organic matter restoration

Contact Address: Raimund Kösters, University of Bonn, Institute of Crop Science and Resource Conservation, Division of Soil Science, Nussallee 13, 53115 Bonn, Germany, e-mail: raimund.koesters@web.de

Potassium: Principal Constraint to Maize Production in *Imperata*-infested Fields at Central Sulawesi, Indonesia

RAQUEL C. LOPEZ, PAUL L. G. VLEK

University of Bonn, Center for Development Research, Ecology and Natural Resources Management, Germany

On tropical soils that are generally acidic and of low fertility, the low-input annual crop cultivation tends to collapse because of *Imperata* weed infestation. Once infested with Imperata, the farmers may only have one or two harvests (e.g. maize) before the weeds completely cover the land. Formerly cultivated fields are fallowed and eventually abandoned when cultivation no longer provides economic returns.

A study was conducted in 2003 / 2004 in a rainforest margin in Central Sulawesi prone to *Imperata* infestation to identify the underlying factor constraining maize production. Maize was planted in fields with different levels of *Imperata* infestation. Before maize cropping, *Imperata* was controlled by shallow or deep hoeing or herbicide application. Maize was grown with and without fertiliser application (NPKS).

Fertiliser application significantly enhanced maize growth in all fields as well as improved the maize grain yield production for 2 cropping periods, particularly in highly-*Imperata* infested field (4.0 t ha^{-1} against 0.1 t ha^{-1}) but also in medium-infested field (8.8 t ha^{-1} against 3.0 t ha^{-1}), and low-infested field (6.3 t ha^{-1} against 2.4 t ha^{-1}). Without any fertility inputs, maize grain production in highly-*Imperata* infested field was severely impeded, but with fertiliser application gave the highest stover yield (10.9 t ha^{-1}).

A detailed analysis of maize nutrient accumulation revealed that K was the key constraining nutrient. In the high-infested field, K levels in the stover tissue were very low, the primary cause for the poor grain development in the highly- *Imperata* infested field. The stover source strength of K was apparently unable to meet the sink demand for grain production. Although many reports state that farmers abandon the field when they can no longer cope with the *Imperata* as the cropping period proceeds, it could be that poor grain production that is discouraging farmers in cultivating such fields. Fertilising the fields early in the infestation process might be a suitable measure to counter *Imperata*.

Keywords: Fertiliser application, Imperata, maize, Nutrient constraints, Potassium, Soil fertility, Tropical soils, Upland agriculture, Weed control

Contact Address: Raquel C. Lopez, University of Bonn, Center for Development Research, Ecology and Natural Resources Management, Walter Flex Str.3, 53113 Bonn, Germany, e-mail: rlopez@uni-bonn.de

Organic Farming and Organic Compounds

Traditional and Ecological Farming Systems in (Sub) Tropical Countries — History, Interactions and Future Perspectives

BERNHARD FREYER

University of Natural Resources and Applied Life Sciences (BOKU), Institute of Organic Farming, Austria

Climate change, soil degradation and an increase of health problems impede a sustainable development of livelihoods in rural areas in (sub-)tropical regions all over the world. Prevalent traditional farming systems have been replaced and modified by the Green Revolution, LEISA and agroforestry systems. Today organic farming is discussed as a land use system which could help especially smallholder farmers to achieve a better income and to protect the environmental resources at the same time. This article reflects first conflict areas and interaction possibilities concerning subsistence farming seen from a system-theoretical perspective. A comparison between traditional and organic farming points out the different qualities. Based on a case study in the Rift Valley / Kenya the development of agriculture since the 1950's along the different land use approaches is demonstrated. The specific environmental risks and the degree of dependency on external inputs, market and economy are shown in a comparison between the different land use approaches. Under specific circumstances organic farming could fail to achieve sound environmental development. Nevertheless because of the system approach, organic farming offers a framework for a sustainable agriculture, integrating forestry, agroforestry, traditional farming techniques and selected approaches from the LEISA system.

Keywords: Agroforestry, LEISA, organic farming, systems analysis

Contact Address: Bernhard Freyer, University of Natural Resources and Applied Life Sciences (BOKU), Institute of Organic Farming, Gregor Mendel Straße 33, 1180 Wien, Austria, e-mail: Bernhard.Freyer@boku.ac.at

How Can Organic Agriculture Contribute to Sustainable Development?

LUKAS KILCHER

Research Institute of Organic Agriculture (FIBL), International Cooperation Division, Switzerland

Organic agriculture can, especially in poorer countries, contribute to meaningful socio-economical and ecologically sustainable development. On the one hand, this is due to the organic practice, which means management of local resources (e.g. local seed varieties, dung, etc.) and therefore cost effectiveness. On the other hand, the market for organic products — at local and international level — has tremendous prospects for growth and offers to creative producers and exporters from the south some excellent opportunities to improve their incomes and living conditions. As to whether organic agriculture is a viable alternative for a particular holding, is something, which can only be clarified case by case.

What are the potentials of organic agriculture for the solution of the hunger and poverty problems? What can organic agriculture contribute to socially and ecologically sustainable development in poor countries?

At the core of organic agriculture are the promotion of soil fertility, biodiversity (e.g. native flora and fauna), locally adapted production methods and the renouncement of chemical inputs. Such methods and the cultivation of diverse crops stabilise the delicate eco-systems in the tropics and reduce drought sensitivity or pest infestations. Organic production lowers the risk of yield failure, stabilises returns and therefore enhances food security of small farmer's families. The author presents examples from international cooperation projects and discusses the following hypothesis on the basis of these examples:

- Organic agriculture is sustainable and diverse;
- Organic farmers conserve resources;
- Organic farms produce more;
- Organic products provide market access and create added value;
- Organic agriculture raises self-confidence and autonomy;
- The organic movement mobilises new forces and partnerships.

Moreover, the author presents a farming system comparison trial, which is starting in kenia and india in cooperation with FiBl and local partners. The aim of this trial is to analize the contribution of organic agriculture to sustainable development.

Keywords: Farming system, organic agriculture, sustainable development

Contact Address: Lukas Kilcher, Research Institute of Organic Agriculture (FIBL), International Cooperation Division, Ackerstraße, 5070 Frick, Switzerland, e-mail: lukas.kilcher@fibl.org

Sustainable Wild Collection of Medicinal and Aromatic Plants

DAGMAR LANGE[1], SUSANNE HONNEF[2]

[1]*University of Koblenz-Landau, Institute for Natural Sciences, Germany*
[2]*WWF and Traffic, Biodiversity, Species Conservation and Traffic, Germany*

Besides cultivation in agricultural production schemes, wild collection of medicinal and aromatic plants (MAP) plays an important role to achieve food and health security according to the Millenium Development Goals of the United Nations. In the case of medicinal plants use, the sustainable collection of these valuable natural resources is a key for the basic health security for around 80 % of the world's population. Additionally, sustainable wild collection provides people in poorer rural regions of our world with a basic income. Between 50,000 and 70,000 plant species are known to be used in traditional and modern medicine systems throughout the world. Countless additional species are used in the growing cosmetics and foods industries. The great majority of MAP species used are sourced by collection from wild resources. Although harvest from the wild may provide incentives for the conservation and sustainable use of important habitats including sensitive plant areas, over-harvesting, land conversion, and habitat loss increasingly threaten a considerable portion (approximately 15,000 species) of the world's MAP species and populations. The available certification criteria or standards addressing wild collection, as for example organic certification schemes, do currently not provide sufficient guidance to ensure the long term survival of wild populations. Means to support the sustainable use of MAP resources are also lacking within the existing systems. Therefore WWF, TRAFFIC, IUCN and the German Federal Agency for Nature Conservation (BfN) started a broad stakeholder consultation in 2005 to develop the International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP). The ISSC-MAP aims to provide the currently missing guidance in form of a set of principles and criteria that can be applied to the management of medicinal and aromatic plant species and their ecosystems.
This paper summarises the rationale, the process and current status and provides an outlook on potential implementation scenarios for this standard.

Keywords: Certification, ISSC-MAP, Sustainable Use, Wild Collection

Contact Address: Susanne Honnef, WWF and Traffic, Biodiversity, Species Conservation and Traffic, Rebstoecker Str. 55, 61130 Frankfurt A.m., Germany, e-mail: honnef@wwf.de

Effects of Legumes Intercropped in Mango Orchards in the Soconusco, Chiapas, Mexico

FRANCISCO MARROQUÍN AGREDA[1], JÜRGEN POHLAN[2], MARC J. J. JANSSENS[1]

[1]*University of Bonn, Institute of Horticulture, Germany*

[2]*El Colegio de la Frontera Sur (ECOSUR), Manejo Integrado de Plagas, Mexico*

Fruit orchards are the principal agricultural crops that generate sustainable economic income to the farmers of the Soconusco Coast, Chiapas. These areas integrate 23000 ha of mango crops cultivated with high chemical inputs, open soil management and flowering stimulation. Outcome of this management is agro-ecological unbalance causing high costs, irregularly yields and requiring quarantine measures for commercial mango orchards in order to prevent infestation with the Mediterranean fly and other fruit flies. In order to alleviate these problems, the principal objectives of this research work were centered around the integration of soil cover with *Crotalaria longirostrata*, *Vigna unguiculata* and *Phaseolus vulgaris* (cv. Escumite) and their effects on fruit development, yield and quality. Since 2005, the effects of different intercropping systems with leguminous crops were integrated in two typical mango fruit regions of the Soconusco. Three leguminous crops i.e. Crotalaria longirostrata, *Vigna unguiculata* and *Phaseolus vulgaris* were evaluated as cash and trap crops, The two trials are each 120×30 m large and encompass four intercropping management systems (traditional, 3 combinations maize + legumes), laid out in a block design with four repetitions. In each experimental unit, growth and yield parameters of intercropped legumes and their interactions with the yield parameters of the companion fruit trees were determined. The experiments are located in in San Felipe (15o16´628´´ north latitude, 92o37´479´´ west longitude and 128 m.a.s.l.) and in Cintalapa (15o19´431´´ north latitude, 92°37´369´´ west longitude and 215 m.a.s.l.). The results demonstrate the potential of leguminous crops to improve the ecological stability in traditional fruit orchards. Crotalaria longirostrata achieved the highest yield of dry biomass (11.04 t/ha) and the treatment with *Vigna unguiculata* produced 1.03 t/ha. The soil covers integrating leguminous crops increase the soil fertility and benefits insect populations. The mango yield was highest in combination with *Phaseolus vulgaris* (9.13 t/ha) and *Crotalaria longirostrata* (7.42 t/ha). Additionally, more abundance and diversity of insect population was observed when intercropping leguminous crops between the mango trees.

Keywords: Chiapas, fruit orchards, insect population, legumes, mango yield, Soconusco, soil cover

Contact Address: Francisco Marroquín Agreda, University of Bonn, Institute of Horticulture, Auf Dem Hügel 6, D-53121 Bonn, Germany, e-mail: fjmarroquin@hotmail.com

Biotechnology Approaches to Modulate Post-harvest Physiological Deterioration of Cassava Storage Roots

JUDITH OWITI, WILHELM GRUISSEM, PENG ZHANG
Institute of Plant Sciences, ETH Zurich, Switzerland

Cassava storage roots play an important role not only as a basic food source for the developing countries but also as starch reserve for the starch industry. Cassava roots undergo post-harvest physiological deterioration (PPD) within 24 hours after harvest, thus reducing the crop's palatability and marketability.PPD is an active physiological process involving changes in gene expression, protein synthesis and accumulation of secondary metabolites. It shares many features with wound responses in other plants, except that wound repair, which seals the wound sites and returns the plant to normal development, is inadequate in the detached cassava root.Information regarding changes in gene and protein profiles during post harvest physiological deterioration is currently scarce.

Using a proteomics approach, the protein expression profiles of cassava during PPD was studied. Proteins were extracted from cassava roots 0 and 12 hours after harvesting and separated by 2D-electrophoresis. Changes in protein profiles were found in cassava roots in the two PPD time points. Gel image analysis identified unique and down-regulated proteins during PPD with annotated functions in protection against oxidative stress and regulation of reactive oxygen species. The characterisation of differentially expressed proteins in cassava storage root during PPD is an initial step towards understanding the mechanisms underlying PPD and will deliver useful tools to modulate the process via genetic engineering.

In parallel, and to further develop the cassava storage root for improved nutrition and storage, we are interested in the isolation of cassava root-specific promoters. Partial isolation and characterisation of root-specific promoter candidates of cassava is ongoing. The obtained information will enable us to generate transgenic cassava with improved nutritional traits and longer storage potential.

Keywords: Keywords: Post-harvest physiological deterioration, protein expression, Two- dimensional electrophoresis

Contact Address: Peng Zhang, Institute of Plant Sciences, ETH Zurich, Universitatstrasse 2, 8092 Zurich, Switzerland, e-mail: pzhang@ethz.ch

Stresses and Biodiversity

Mycoherbicide Research and Development for Integrated *Striga* Control in Africa: Achievements, Constraints and Future Perspective

ABULEGASIM ELZEIN[1], JÜRGEN KROSCHEL[2], PAUL MARLEY[3], GEORG CADISCH[1]

[1]*University of Hohenheim, Institute of Plant Production and Agroecology in the Tropics and Subtropics, Germany*

[2]*International Potato Center, Integrated Crop Management Division, Peru*

[3]*Ahmadu Bello University, Institute for Agricultural Research, Nigeria*

Striga spp. are important constraints in cereal and legume production in semi-arid tropical Africa, where the livelihood of millions of subsistence farmers is adversely affected. An integrated approach in which biocontrol represents an important component, appears to be the ideal strategy for reducing *Striga* infestation. *Fusarium oxysporum* (Foxy 2 & PSM197) proved to be highly virulent against their target weed *Striga hermonthica*, host specific and they can be mass-produced. For facilitating practical field application, our research focuses on the development of appropriate mycoherbicidal formulations and delivery systems of the fungal antagonists. Hence, Pesta formulation, made by encapsulating fungal inoculum in a matrix composed of durum wheat-flour, kaolin, and sucrose, was developed. Seed treatment technology for coating sorghum and maize seeds as an attractive option for further minimising the inoculum amount and facilitating delivery of *Striga*-mycoherbicides was also investigated and an optimised coating protocol for antagonists of *Striga* was provided. Both formulations showed promising efficacy in controlling *Striga* and in improving the panicle yield of its host plant sorghum under glasshouse conditions. Integration of Pesta formulation and treated seeds containing *Striga*-mycoherbicides with *Striga* resistant and susceptible sorghum and maize cultivars under field conditions revealed an additive effect. The resistant cultivars enhanced clearly both mycoherbicides efficacy in controlling *Striga*. These findings are highly relevant to the realisation of an integrated *Striga* control approach. Both technologies "Pesta and seed treatment" offer a significant practical and economical solution for large-scale application of antagonists for *Striga*. Further, both mycoherbicides maintained excellent viability (shelf-life) on Pesta products and treated seeds after one year of storage which would be sufficient for their use under practical conditions of storage, handling and delivery. The compatibility and suitability of Pesta and seed treatment technology for formulating and delivering *Striga*-mycoherbicides will contribute to solving the primary difficulties for underemployment of *Striga*-mycoherbicides in Africa. Strategies about how to utilise these progresses to formulate successful integrated *Striga* control methods adoptable and applicable by subsistence farmers were proposed.

Keywords: Encapsulation, *Fusarium oxysporum*, Future prospective, Integrated approach, Mycoherbicide, Seed coating, *Striga hermonthica*, weed biological control

Contact Address: Abulegasim Elzein, University of Hohenheim, Institute of Plant Production and Agroecology in the Tropics and Subtropics, Garbenstr. 13, D-70599 Stuttgart, Germany, e-mail: gasim@uni-hohenheim.de

Indicators for Land Use in Savannahs — Solutions for Detecting and Describing Land Use Intensity

ANJA LINSTÄDTER

Savanna Range Management - Ecological and Economic Sustainability, University of Cologne, Germany

Tropical savannahs like other arid to semiarid environments are characterised by a high temporal and spatial variability of rainfall. For understanding crucial aspects of any land management adapted to these conditions, we need to consider the full spatio-temporal dynamics of natural resources such as water availability and biomass production. A major challenge here are feedbacks between land use and spatial and temporal gradients. These feedbacks address thresholds, spatial and temporal scaling (including ecological and socio-economic memory), and both local and scientific perception of land use intensity. For detecting and describing land use intensity on a local and regional level, natural indicators are needed. They are necessary for a standardisation of different types of human impact such as grazing, browsing, or woodcutting; and for a standardisation of human impact on natural resources such as water and biomass.
Such indicators are classified and described for land management in arid and semi-arid environments, distinguishing between **(i)** direct indicators for the current state of a natural resource (e.g. available biomass, species composition), **(ii)** indirect indicators for the current state of natural resources (e.g. milk yield, calving rates), and **(iii)** direct indicators for an ecosystem memory (e.g. the population structure of key species, or the vitality of fodder species). For the case of the savannah biome, we give regional examples for the indicative value of vegetation and soil. In particular, we present the value of plant functional types (PFTs) and their abundance along land use gradients. We link existing conceptual approaches such as the concept of increaser/decreaser species to the functional concept of Response Groups, i.e. species with the same answer to disturbances. The significance of indicative functional groups in the tree and grass layer is discussed for the savannah biome in general.

Keywords: Africa, indicators, land management, land use gradients, Namibia, range ecology

Contact Address: Anja Linstädter, Savanna Range Management - Ecological and Economic Sustainability, University of Cologne, Gyrhofstr.15, 50937 Cologne, Germany, e-mail: anja.linstaedter@uni-koeln.de

Interaction Between the Physiological State of *Ralstonia solanacearum*, Causal Agent of Bacterial Wilt, in Tomato Xylem Vessels and the Tomato Genotype

K. WYDRA, ZEKARIAS LEYKUN
University of Hannover, Institute of Plant Diseases and Plant Protection, Germany

Bacterial wilt caused by *Ralstonia solanacearum* is difficult to control due to the high variability of the pathogen and its capability to survive easily in adverse environments. Therefore, use of resistant genotypes is the key option for integrated control. However, latent infection may cause breakdown of resistance, pathogen dissemination or substantial yield reduction even with low wilt incidence. Therefore, the level of latent infection was quantified in fourteen 'resistant' tomato genotypes in relation to wilt incidence. *R. solanacearum* was detected in the collar of all symptomless genotypes and, hence, initial root infection was not limiting for bacterial colonisation. Highest differences in bacterial numbers were observed in the mid-stem parts of 'resistant' genotypes suggesting existence of effective resistance mechanisms on mid-stem level in some genotypes. Immunohistochemical analysis revealed differential reactions in xylem cell wall structure and composition in resistant and susceptible genotypes. Bacterial numbers and wilt incidence were positively correlated, with a higher correlation coefficient in the mid stem parts than in lower or upper plant parts. Therefore, quantification of bacteria in the mid-stem is suggested as a complementary criterion in addition to wilt symptom evaluation to identify genotypes, which suppress the latent pathogen multiplication.

The ability of *R. solanacearum* to enter the viable but non-culturable (VBNC) state in planta was examined in different genotypes after infection. A significant percentage of *R. solanacearum* cells entered the VBNC state in xylem vessel, increasing in number with time after infection in symptomatic plants. The influence of the plant on the phase change of the bacterium could be an additional characteristic for the selection of resistant genotypes.

Keywords: Bacterial wilt, host plant resistance, Ralstonia solanacearum, tomato

Contact Address: K. Wydra, University of Hannover, Institute of Plant Diseases and Plant Protection, Hannover, Germany, e-mail: wydra@ipp.uni-hannover.de

Diversity of Geminiviruses Causing Cassava Mosaic Disease in Africa

STEPHAN WINTER

Deutsche Sammlung von Mikroorganismen und Zellkulturen (DSMZ), Plant Virus Division, Germany

Cassava mosaic disease (CMD) caused by whitefly transmitted geminiviruses occurs wherever cassava is grown in Sub Sahara Africa, presents a serious constraint to cassava production and serious yield losses. The viruses causing CMD reflect a considerable molecular diversity with 6 distinct species so far described resolving in numerous and diverse strains and virus isolates. The cassava mosaic geminiviruses are believed to have initially evolved from indigenous African viruses which adapted to cassava and now occur, either with overlapping distribution over larger geographies, as with African cassava mosaic virus and East African cassava mosaic Cameroon virus or, with a more discrete occurrence as is the case for East African cassava mosaic Zanzibar virus found only in coastal areas of East Africa, Kenya and the island of Zanzibar. The large molecular diversity with viruses from East Africa points to East Africa as the centre of diversification. In addition and more significantly recombination evident in a number of virus genomes is a driving force of geminivirus evolution. Virus diversity and frequent recombination events found in virus genomes provide evidence for continuous evolutionary processes and influence the development of epidemics and the emergence of "new" viruses. The knowledge of virus diversity, the geographic distribution of virus types and the structure of virus populations is a most significant prerequisite to deploy cassava with virus resistance characters. A description of the current status of cassava geminiviruses in Sub Sahara Africa and the diverse phenotypes found in cassava will be presented and discussed in light of putative strategies to challenge CMD in Africa.

Keywords: Cassava mosaic disease, CMD in Sub Sahara Africa, geminivirus diversity

Contact Address: Stephan Winter, Deutsche Sammlung von Mikroorganismen und Zellkulturen (DSMZ), Plant Virus Division, BBA, Messeweg 11/12, Braunschweig, Germany, e-mail: s.winter@bba.de

Production Systems and Environment

Regional Water Issues and Pollution

Catchment Characteristics as Predictors of Base Flow Index (BFI) in Wabi-shebele River Basin, East Africa

ADANE ABEBE, GERD FOERCH

University of Siegen, Germany, Research Institute for Water and Environment, Civil Engineering Department, Germany

The Base Flow Index (BFI) is used as a measure of the base flow characteristics of catchments. It provides a systematic way of assessing the proportion of base flow in the total runoff of a catchment. It indicates the influence of soil and geology on river flows, and is important for low flow studies. Nowadays extreme low flow events are more diligently analysed and given focus in the emerging field of ecohydrology. However, many of the catchments in developing countries are ungauged, thus, it is often difficult to get recorded data on base flows of rivers. This paper seeks to establish a relationship between the climatic, morphologic and geologic features of a catchment to its base flow in the Wabi-Shebele river basin, East Africa. It employs the parameters catchment size, stream density, climate index, soil type, hypsometric integral, normalised digital vegetation index (NDVI) extracted from satellite images and geologic features to derive the base flow index of a catchment. Values of base flow index determined for a network of stream flow gauges are matched to the composite morphometric and climatic data using spatial and regression analyses. To relate the BFI to a usable flow statistic, a relationship was derived between BFI and Q70, the point on the flow duration curve at which flows are exceeded 70 % of the time. Q70 was chosen because it is the critical point that has been most often used in most previous works. The BFI has a strong relationship with climate and geology. Catchments with high climate index (high rainfall or low evapo-transpiration) underlain with granites or basalt tend to give high base flow. Among the topographical parameters tested, drainage density index has better relationship with BFI. The developed relationship can be used for fairly estimating the base flows in the river basin considered. However, in view of the tremendous spatio-temporal heterogeneity of climatic and landscape properties extrapolation of response information or knowledge from gauged to ungauged basins remains fraught with considerable difficulties and uncertainties.

Keywords: Base flow index, catchment characteristics, GIS, ungauged basins, Wabi-shebele river

Contact Address: Adane Abebe, University of Siegen, Germany, Research Institute for Water and Environment, Civil Engineering Department, Paul-Bonatz-Str.9-11, 57076 Siegen, Germany, e-mail: adane.abebe@uni-siegen.de

Different Drought Adaptation Strategies of *Coffea Arabica* Populations Along a Rainfall Gradient in Ethiopia

JÜRGEN BURKHARDT, ALICE BEINING, TAYE KUFA, HEINER GOLDBACH
University of Bonn, Institute of Crop Science and Resource Conservation - Plant Nutrition, Germany

Ethiopa is the centre of genetic diversity of *Coffea arabica*. The CoCE project aims to assess the diversity and the economic value of the Ethiopian coffee gene pool, focussing on traits inherent to the wild coffee populations and their possible usefulness for breeders.
We compared the water use of four wild *Coffea arabica* populations along a rainfall gradient in Ethiopia. Measurements were carried out *in situ*, as well as in an experiment where seeds of the original sites were used to raise seedlings. Measurements tackled all relevant parts of water transport, i.e. soil conditions, the hydraulic conductivity of the root and the shoot system, stomatal control of gas exchange, and the atmospheric demand for water vapour.
Water use efficiency *in situ* was found to be higher in the dry than in the wet season, and on dry sites compared to wet sites, thus reflecting the availability of water. Unexpectedly, no correlation with the rainfall gradient was observed neither when measuring the hydraulic system *in situ*, nor when looking at the reaction of seedlings to drought and radiation stress under *ex situ* conditions. Plants from the driest site, Harenna, showed highest transpiration and production. The root system of Harenna trees was the most extensive compared to the other sites, and the hydraulic system showed the highest efficiency for water transport, stomatal behaviour was liberal. Therefore these plants were most vulnerable to drought stress, and eventually they were the first of all to be damaged by drought. Plants from the wettest site were most conservative in water use and longer withstood drought stress, but had lower productivity.
The results showed that the precipiation gradient was not reflected in a simple way by drought stress tolerance of trees. Presumably populations follow different strategies under drought stress conditions. Harenna populations might find their way out of serious droughts by putting their main effort into seed production (conserving the population as a whole), while trees from other populations seem to be more oriented to ensure survival of the individuals.

Keywords: Biodiversity, *coffea arabica*, in-situ conservation, water relations

Contact Address: Jürgen Burkhardt, University of Bonn, Institute of Crop Science and Resource Conservation - Plant Nutrition, Karlrobert-Kreiten-Straße 13, 53115 Bonn, Germany, e-mail: j.burkhardt@uni-bonn.de

Economic Assessment of Water Saving Irrigation Methods in Longan Production in Northern Thailand

KANITTA SATIENPERAKUL[1], WOLFRAM SPREER[2], WINAI WIRIYA-ALONGKORN[3], SOMCHAI ONGPRASERT[4], JOACHIM MÜLLER[2]
[1]*Mae Jo University, Faculty of Economics, Thailand*
[2]*University of Hohenheim, Agricultural Engineering, Germany*
[3]*Mae Jo University, Department of Horticulture, Thailand*
[4]*Mae Jo University, Department of Soil Conservation, Thailand*

With a total acreage of more than 100,000 ha longan (*Dimocarpus longan* Lour.) is one of the most important fruit crops cultivated in northern Thailand. With flowering and main fruit development taking place during the dry season, irrigation is needed to ensure high yields and optimal produce quality. Water for irrigation is an increasingly scarce resource in the region as a whole and for the single farmers irrigation is related to high energy costs for pumping. Deficit irrigation strategies present an interesting alternative to increase water use efficiency (WUE), wherever water is a limiting factor to production. Therefore, at Mae Jo University, Thailand in cooperation with Hohenheim University, Germany, deficit irrigation strategies are tested in tropical fruit tree orchards and evaluated with respect to yield and plant responses to drought stress. Over two years of field experiments it was documented, that under "partial rootzone drying (PRD)" high yield can be obtained with 33 % reduced irrigation water use. Responding to farmers' request, a farmer controlled experiment was set up, where conventional irrigation was compared to deficit irrigation under field conditions. 180 trees have been split in to three groups: a. Farmer's irrigation (control), b. Optimised irrigation based on open pan evaporation and c. PRD with 60 % of calculated optimal irrigation, alternately applied to different parts of the rootzone. Irrigation frequency and water consumption was recorded during the irrigation period. Total yield and yield per tree was measured, as well as fruit size and colour, as the most relevant quality parameters. Based on this data and under consideration of the current market prices for longan, an analysis of the economic suitability of deficit irrigation was carried out. The specific costs of irrigation were calculated under different scenarios regarding energy costs and possible water prices. It was shown, that mainly the reduced costs for pumping make deficit irrigation attractive to farmers. Despite slightly lower yields, PRD was more cost effective due to energy savings. Different scenarios of water pricing offer institutional instruments to promote water saving irrigation practices.

Keywords: Deficit irrigation, dimocarpus longan, fruit quality, PRD, yield

Contact Address: Wolfram Spreer, University of Hohenheim, Agricultural Engineering, 70593 Stuttgart, Germany, e-mail: Wolfram.Spreer@gmx.net

Drinking Water Policy, Water Rights and Allocation Practice in Rural Northern Ghana

IRIT EGUAVOEN

Centre for Development Research (ZEF), Social and Political Change (ZEFa), Germany

Present international drinking water policy dictates communal management of improved rural water supply facilities, such as hand pump fitted boreholes, to guarantee their technical sustainability and better access to water. Ghana has adopted and implemented that approach countrywide in its National Community Water and Sanitation Program.

Some concepts, which the NCWSP policy suggests, contradict both former local water right regime and local perceptions of water. Among them are water tariff, formal user community and rights to exclude others from access. Pump communities are challenged to balance and deal with project legislation and borehole management guidelines deriving from water policy, as well as with socio-cultural norms, ecological circumstances and practical needs, which all embody divergent management priorities and request for different norms applied in such management.

What empirical impact has the international drinking water approach on the local management of household water? What institutional and conceptual changes have emerged in comparison with the former water right regime? And what are the consequences for the access to water and local water allocation practice?

The drinking water policy implemented in rural Ghana has provoked major changes in the local household management regime. The formal membership in bounded user communities, which hold a monopoly on property, use and decision-making rights for the facility, was introduced. The regular payment of money for rural water supply was extended to all regions. Pump communities got encouraged to sanction non-payment with the exclusion from access. But crafted institutions were negotiated on local level to balance contradictions between them and the former water right regime. Non-members of formal user communities may obtain use rights, which limit the amount of water, the water use and the withdrawal time. Payments were conceptualised as maintenance fees not as water tariffs. And additional rules and the close linkage of property and use rights prevent the exclusion of users due to non-payment. Despite new conceptual design and diversification of water rights and rules, water allocation practice does not show major changes but rather depends on non-normative factors.

Keywords: Communal management, household water, water rights

Contact Address: Irit Eguavoen, Centre for Development Research (ZEF), Social and Political Change (ZEFa), Walter-Flex-Str. 3, 53113 Bonn, Germany, e-mail: eguavoen@uni-bonn.de

Determinants of Farmers' Acceptance of Treated Wastewater in Irrigated Agriculture in the Northern Gaza Strip

AHMED ABU SHABAN, WERNER DOPPLER, HEINZ-PETER WOLFF
University of Hohenheim, Farming and Rural Systems in the Tropics and Subtropics, Germany

The Gaza Strip suffers from a critical scarcity of water and competition for water resources is high between the different sectors of the Palestinian economy. Prognoses indicate that the use of water as a production mean in agriculture will have to rely on the increased exploitation of treated wastewater (TWW) in the future. The change from freshwater to TWW is not a mere technical challenge but implies changes in the current rights for exploiting freshwater resources. Knowledge about the determinants of farmers' acceptance of TWW is a prerequisite for the support of an unobstructed transition from the current situation to the expected management of water resources in the future.

The analysis of determinants of farmers' acceptance was based on data from a random sample of 94 farmers in the Biet Hanoun Area. The study area is located in the Northern Gaza Strip and will become a site with TWW irrigation according to the plans of the Palestinian Water Authority. A classification according to farm activities and family income yielded three classes of farming systems: mixed cropping farmers (A), low-income perennial crop farmers (B) and high-income perennial crop farmers (C). Acceptance of TWW was significantly lowest in class A, but showed no difference between farmers from the classes B and C, whereby the fear of diseases and pollution through TWW use was the most frequently stated concern. Further analyses by a logistic regression model revealed that this concern was the major determinant of farmers' negative attitude towards the use of TWW and has an even larger impact than the ownership of own wells, which ranged on the second place. Major determinants for a positive attitude are the possession of hitherto non-irrigated areas and the structure of cropping activities. Literacy of farmers played an ambiguous role and may work in both directions. The overall highly significant results of the model support the hypothesis, that acceptance of TWW may origin from better access to information as well as from the lack of awareness of potential side effects.

Keywords: Farming system, logistic regression, wastewater

Contact Address: Ahmed Abu Shaban, University of Hohenheim, Farming and Rural Systems in the Tropics and Subtropics, Fruwirthstraße 12, 70599 Stuttgart, Germany, e-mail: ahmedschaban@hotmail.com

Farming Systems Management

Upgrading and the Value Chain Analysis: The Case of Small-scale Coffee Farmers in Honduras

INGRID FROMM[1], JUAN A. DUBON[2]

[1]*University of Leipzig, Small Enterprise Promotion and Training Program, Germany*

[2]*Georg-August-Universität Göttingen, Institute of Agricultural Economics, Germany*

The body of literature and research related to the value chain analysis has increased in recent years. These studies examine trade and production networks at an international level. Up to now, there is little evidence of the opportunities for developing countries to integrate into the world market with agricultural products. However, the export of value-added and differentiated agricultural products opens possibilities for development and poverty reduction. There is evidence that small producers and exporters in developing can insert themselves successfully in agricultural value chains. Small-scale producers, in their interaction with local processors or exporters and international retailers, have the possibility to acquire new skills and knowledge. The type of trust relationship and power dependence among the actors can determine how information flows and how firms upgrade. On the other hand, the implementation and compliance with standards provides opportunities for learning and acquiring skills and knowledge. The case of small-scale coffee farmers in Honduras illustrates this point. There are over 70,000 coffee producers in Honduras, most of which grow coffee on farms of less than 10 hectares of land. One of the challenges coffee producers have faced in the last 15 years has been the falling prices in the international market. Local institutions and producers' cooperatives have created programs to help small-scale coffee farmers adapt to the changes in the global marketplace and assist them in increasing their competitiveness. These initiatives include the implementation of quality standards, the identification of direct buyers to ensure higher profits, and the certification of origin. The aim of this paper is to analyze the impact of these initiatives by studying how small-scale coffee farmers have upgraded their production and processes in order to increase their competitiveness and profits.

Keywords: Competitiveness, upgrading, value chains

Contact Address: Ingrid Fromm, University of Leipzig, Small Enterprise Promotion and Training Program, Germany, e-mail: ifromm@yahoo.com

Banana Improvement Based on Tissue Culture Propagation, Bio-enhancement and Agronomic Management for Sustainable Production

LUIS POCASANGRE

International Network for the Improvement of Banana and Plantain (INIBAP), Costa

The propagation of banana using tissue culture techniques has completely changed the banana industry. Firstly, the rapid increase of areas planted with banana in the last two decades has been possible only with this technique. For example, Ecuador, which is now the largest banana exporter in the world, only had 48,000 ha planted with banana in 1985, by 2000, this area had increased to almost 190,000 ha. This increase of 142,000 ha would not have been possible with conventional propagation systems. Secondly, banana producing countries in Central America are severely and regularly affected by hurricanes. Every year, thousands of hectares are destroyed by hurricanes and flooding. Tissue culture techniques allow for these areas to be rapidly replanted. The advantages of using tissue culture plants in comparison to traditional planting materials, such as sucker, bits, or corms are well known: uniformity of a plantation's synchronised ratooning, superior agronomic behaviour and higher production. Furthermore, tissue culture plants are free of nematodes, weevils and some pathogenic fungi, which can be disseminated by suckers. Another breakthrough of this technique is the strong support to the plant-breeding programme. At the present, more than 72 countries benefit from pest and diseases resistant hybrid, and incalculable tons of pesticides have been saved in those countries through the introduction of resistant hybrids. However, this technique does not only have advantages. Somaclonal variation is still a problem. Currently, the majority of commercial tissue culture laboratories have less than 5 % off-type plants, but in some cases, they can reach up to 10 %. Another disadvantage of tissue culture plants is that they are more susceptible to the attack of nematodes, weevils and soil borne pathogens than suckers, as they are produced under sterile conditions in laboratories and are free of beneficial microorganisms that are normally present in field suckers. In order to solve this problem, we are working on the biological enhancement of tissue culture plants with mutualistic endophytic fungi. This involves the inoculation of plants with endophytic fungi that have antagonistic activity towards nematodes and other biotic factors and also a positive effect on plant growth. Currently, we are evaluating these endophytes in five countries in Latin America and we have more than 35 ha planted with inoculated plants. Preliminary results in commercial plantations in Costa Rica indicate that one single inoculation with endophytes has a better nematode control effect than 3 nematicide applications. Studies are being conducted at CATIE, Costa Rica, at IITA, Uganda, and at the University of Bonn, Germany, to elucidate the mechanisms of action of the endophytes.

Keywords: Endophytic fungi, nematodes, somaclonal variation, South America

Contact Address: Luis Pocasangre, International Network for the Improvement of Banana and Plantain (INIBAP), INIBAP c/o CATIE, 7170 Turrialba, Costa, e-mail: lpoca@catie.ac.cr

Crop Yield Variability and Risk Aversion as Barriers to the Adoption of Fire-free Land Preparation in the Eastern Brazilian Amazon?

JAN BÖRNER[1], STEPHEN A. VOSTI[2], ERNST BERG[3]

[1]*Technical University of Munich, Department of Agricultural Economics, Germany*
[2]*University of California, Department of Agricultural and Resource Economics, United*
[3]*University of Bonn, Department of Farm Management, Germany*

In the Brazilian Amazon and at many other forest margins in the humid tropics, small-scale farmers depend primarily on low-input agriculture. The mechanisation of land preparation is often proposed as a profitable and climate-friendly alternative to the traditional fallow-based slash-and-burn practice. Yet, adoption rates remain rather low.

Although the high economic performance of mechanical land preparation in experiments is primarily due to fertilisation, many proponents tacitly assume that chemical fertilisers are being adopted together with the mechanisation method. The question that motivates this paper is therefore: Why don't farmers use fertilisers to increase the productivity of the traditional production system in the first place?

Based on farm-household data from 270 smallholders in the Eastern Brazilian Amazon we find that factors, such as income, liquidity constraints, labour endowment and social connectedness have little or no explanatory power with respect to fertiliser use. Instead, fertilisers seem to be used only for crops that are clearly unprofitable without fertilisation.

In a further step we simulate a set of production functions that identify expected yield and yield variance of important annual and perennial crops as a function of fertiliser use. The production functions are integrated into a quadratic farm-household optimisation model that accounts for production and price risks. The model suggests that risk aversion can induce farmers to increase or decrease fertiliser use intensity depending on how crop yield variance responds to fertiliser application.

We use the model to assess the potential of a technology-specific crop-yield insurance scheme to induce the adoption of fire-free mechanical land preparation methods that require fertiliser applications. A final section elaborates on the implications of the results for the design of agricultural research and agro-environmental policies in the humid tropics.

Keywords: Optimisation, simulation, slash-and-burn, small-scale argriculture

Contact Address: Jan Börner, Technical University of Munich, Department of Agricultural Economics, Alte Akademie 14, 85354 Freising, Germany, e-mail: boerner@wzw.tum.de

Poverty Alleviation through Diversification: Potential and Constraints of Integrated Agriculture Aquaculture (IAA) for Poor People in the Rural Philippines - Evaluation at Farm Level

MARCO HARTMANN[1], HANS E. JAHNKE[2], KURT-JOHANNES PETERS[3]

[1]*NGO CIAAP, Cabayugan Integrated Agriculture Aquaculture Project, Philippines*

[2]*Humboldt-Universität Berlin, Development Planning and Project Management, Germany*

[3]*Humboldt-University Berlin, Department of Animal Breeding in the Tropics and Subtropics, Germany*

Elaborating sustainable livelihood approaches to reduce poverty is a continuing challenge for development planners throughout the developing world. In Southeast-Asian countries, small scale farming, rice farming in particular, represents the dominat source of income. Due to low prices, stagnant or decreasing yields and changes in climate, rice production is becoming less profitable for farmers. The role of poor farmers in degrading natural resources while searching for accessible income sources is well known in the Philippines. Small scale farmers are confronted with the problem of declining productivity in rice farming and a limited farm output, which frequently is not enough to provide income or at least food for the farm household throughout the year. Farmers are forced to look for alternatives, which simultaneously favours farm diversification as a possible option. In this presentation, panel data collected in the Philippine province of Palawan are used to point out the conditions of small scale farming and predominant constraints farmers are facing today. Diversification of existing farming systems can play a significant role in improving livelihoods of the farming households. Basically, poor rural people do not rely for their livelihood on agriculture alone, but as long as there are few opportunities due to almost non-existing labour markets in remote areas, practical solutions on the field have to be elaborated to overcome food shortages. Data from an economic analysis of an integrated agriculture aquaculture (IAA) farming system at a model-project site “on-station” provides evidence of the potential of diversification to alleviate poverty of small scale farmers in the region. Utilizing this data as a foundation, attention focuses on practical possi-bilities “on-farm” of implementing IAA components to diversify individual production systems and to identify deriving economic impacts and constraints of the adjustment.

Keywords: Diversification, Integrated Agriculture Aquaculture , poverty alleviation

Contact Address: Marco Hartmann, NGO CIAAP, Cabayugan Integrated Agriculture Aquaculture Project, P.O. Box 195, 5300 Puerto Princesa City, Philippines, e-mail: m.hartmann@ciaap.com

The Spread of Innovations Within Formal and Informal Farmers Groups: Evidence from Rural Communities of Semi-arid Eastern Africa

DIETRICH DARR, JÜRGEN PRETZSCH

Technische Universität Dresden, Institute of International Forestry and Forest Products, Germany

Novel ideas and farming practices spread, and often enough even evolve, through interpersonal interaction and communication in rural communities. Hence, facilitating cooperation and exchange among farmers becomes a core objective of most extension interventions. Formal and informal farmers groups can play an active role to promote the diffusion of knowledge and technologies and thus to improve the efficiency and efficacy of the technology extension efforts.

This paper describes the effect of structural and functional variables of farmers groups on the spread of agroforestry innovations and tree management related knowledge among the group members. Specifically, it was hypothesised that **(a)** group cohesiveness, **(b)** group activity and **(c)** member motivation will each be positively related to the spread of the technologies among the group. Group social networks represent the main analytical level and units of analysis. The technology adoption behaviour of individual farm households serves to operationalize the diffusion variable.

Four full sample surveys of approximately 200 households each have been conducted in two districts of Kenya and Ethiopia, respectively. 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.

The research results clearly support the main hypotheses. The study further presents empirical evidence that illustrates the innovative potential of cohesive farmers groups and social interaction networks, and that exists in spite of the prevailing top-down and largely persuasive extension approaches that currently are being adopted in the four study areas. Recommendations refer to the improvement of formal and informal farmers groups in order to facilitate the agroforestry extension work.

Keywords: Agroforestry extension, diffusion of innovations, groups, social networks

Contact Address: Dietrich Darr, Technische Universität Dresden, Institute of International Forestry and Forest Products, Pienner Str. 7, 01737 Tharandt, Germany, e-mail: dietrich.darr@forst.tu-dresden.de

Valuation of Non-market Goods: Farmer Health in Nicaragua

HILDEGARD GARMING

University of Hannover, Department of Business Administration and Economics, Germany

Pesticide use is a major factor in farmer health. Pesticide poisoning in Nicaragua affects at least 5 % of farmers every year. Economic valuation of health effects is important in order to stimulate the diffusion of healthier farming practices. Methodologies for economic evaluation of these effects have been developed but actual applications in developing countries reamin scarce.

This paper presents the results of an assessment of the health costs of pesticides by Nicaraguan vegetable farmers. A contingent valuation approach was used to measure farmers' willingness to pay (WTP) for low toxicity pesticides. This approach includes market and non-market health costs and allows to also assess the chronic health effects of pesticides, rarely included in such studies.

Results show that farmers are aware of the health risks of pesticides and have a positive willingness to pay to avoid poisoning. 85 % of the surveyed farmers gave valid WTP estimates and about 80 % of these stated a positive WT*P. A*verage WTP for avoiding health risks is about 28 % of current pesticide expenditure and is higher than actual expenses for acute poisoning. The validity of these results is established through scope tests, comparing WTP for pesticides with different toxicity levels and a two step regression model. Logistic regression is used to analyse positive willingness to pay statements. The variation of the stated WTP is then analysed in a log-linear regression model. The tests show that WTP depends on farmers' previous experience with pesticide poisoning, income, access to finance and pesticide exposure as measured by pesticide use intensity.

The results of this study can contribute to a better targeting of rural health policies and the design of programmes aiming to reduce negative effects of pesticides.

Keywords: Economic evaluation, Nicaragua, pesticide poisoning, willingness to pay

Contact Address: Hildegard Garming, University of Hannover, Department of Business Administration and Economics, Königsworther Platz 1, Hannover, Germany, e-mail: garming@ifgb.uni-hannover.de

Social Ecology and Land Use

Analysis of Diverging System Perspectives for Achieving Sustainable Agricultural Production

REGINA SCHOELL, CLAUDIA R. BINDER

University of Zürich, Social and Industrial Ecology, Department of Geography, Switzerland

Sustainable agricultural production provides an important contribution for improving farmer's livelihood. It also includes proper handling of pesticides to increase productivity and reduce health and environmental risks. Educational programs to improve pesticide handling have not had the expected effect. We consider that diverging system perspectives among farmers and experts hinder the implementation of sustainable agricultural production techniques. We present and discuss the potential of the Mental Model Approach (MMA) for investigating the diverging system perspectives of stakeholders and show first results from an empirical case study of agricultural production in Colombia. We adapted MMA for analysing the differences and misunderstandings between experts and farmers perspectives regarding farmers' livelihood and agricultural system dynamics.10 experts and 10 farmers were interviewed. The questions included **(i)** definition of the four livelihood capitals (health, human, physical and natural capital); **(ii)** the relationship and dynamics among the capitals within farmer's production system; and **(iii)** the listing of actors in the farmer's agricultural production context. Qualitative and statistical analysis of the data provided a general system and 10 system diagrams for each group. Additionally for each person interviewed the deviation from the general "expert" or "farmer" system was determined. Finally we gained an overall view of all perceptions of the system as well as their divergences and critical tradeoffs regarding their management decisions. Our analyses showed that the system perception differed between experts and farmers in three aspects: **(i)** capitals definition and ranking with respect to importance for the sustainability of farmers livelihood; **(ii)** understanding of the system and its dynamics; **(iii)** importance of the agents in the farmers' agent network. These results suggest that measures solely developed by experts will not have the desired effect as they depart from a different systemic logic than the one farmers have. The comprehension of the mental models of experts and farmers could be extremely valuable for developing measures to improve farmers' agricultural production system leading to a more sustainable livelihood.

Keywords: Livelihood, Mental Model Approach, pesticides, sustainable agricultural production

Contact Address: Regina Schoell, University of Zürich, Social and Industrial Ecology, Department of Geography, Winterthurerstrasse 190, 8057 Zurich, Switzerland, e-mail: schoellr@geo.unizh.ch

Validity vs. Feasibility? - Monitoring Ecological Effects of the Extraction of Non-timber Forest Products in Developing Countries

ALEXANDER FRÖDE

German Development Service (DED) Zimbabwe, Southern Alliance for Indigenous Resources (SAFIRE), Zimbabwe

Small-scale commercialisation of non-timber forest products (NTFPs) has been widely advocated as an option for income generation in rural woodland areas of developing countries. It was claimed to often be environmentally sustainable even without regulation, therefore posing an attractive alternative solution to destructive logging and land conversion activities. However, scientific research and practical experiences have given evidence that each commercial extraction a non-timber forest resource entails measurable ecological effects.These vary in detail with the amounts and plant parts harvested, the techniques used and the management procedures in place. Against the background of these risks and the complexity of woodland dynamics, ecological monitoring, i. e. the repetitive observation of biotic and abiotic parameters in the concerned areas, is of a crucial importance. The paper summarises an analysis of framework conditions und practical requirements for an expedient system of ecological monitoring for NTFP-related projects at the example of SAFIRE (Southern Alliance for Indigenous Resources), a Zimbabwe-based regional non-governmental organisation that facilitates extraction of various types of NTFPs by rural communities. It describes the process of developing an appropriate set of methods and presents the final ecological monitoring system as well as first experiences in its implementation. The methodology that was developed was meant to be adapted to the needs of the organisation, integrated into its procedures, applicable to varied NTFP commercialisation projects and compliant with various framework requirements. The process and the product are indicative of dealing with the challenges faced by ecological monitoring in NTFP-related initiatives in developing countries: the lack of reliable baseline data, the need to define and use highly aggregated core indicators, limited financial, technical and human resources and difficulties in deducting evidence for long-term trends from locally and temporally limited natural phenomena. Inter alia, the outputs emphasise how scientific rigour and the necessity for reliability and accuracy have to be carefully weighted against motivation, skills and restrictions of different stakeholders and available resources.

Keywords: Ecological monitoring, forestry, non-timber forest products, rural development, sustainable land-use, Zimbabwe

Contact Address: Alexander Fröde, German Development Service (DED) Zimbabwe, Southern Alliance for Indigenous Resources (SAFIRE), c/o DED, 2 Morecambe Av/Bishops Road, P. O. Box 3362, Belvedere, Harare, Zimbabwe, e-mail: alexander.froede@gmx.net

Impact of Water Point on Rangeland Condition and Spatial Distribution of Vegetation and Soil Nutrients

GEMEDO DALLE TUSSIE[1], BRIGITTE L. MAASS[2], JOHANNES ISSELSTEIN[2]
[1]*Institute of Biodiversity Conservation, Forest Genetic Resources Conservation, Ethiopia*
[2]*Georg-August-University Göttingen, Department of Crop Sciences, Germany*

The impact of livestock grazing on rangeland condition, woody plants encroachment, spatial distribution of soil nutrients and herbage mass change along the grazing gradient was investigated. The study was conducted using non-permanent plots established at regular interval on line transects radiating from Dambi Pond in Dida Hara Pastoral Association of Yaballo district, Borana, Ethiopia. Effects of distance from the Pond were analysed using linear regression, Detrended Correspondence Analysis (DCA), and Redundancy Analysis (RDA). Results showed that the composition of herbaceous vegetation changed from a community of *Eleusine intermedia-Cynodon dactylon* close to the Pond to *Chrysopogon aucheri- Sporobolus pellucidus* farther away from the Pond. Three distinct zones were determined. The zone closest to the Pond was characterised by unpalatable forbs, least desirable/undesirable grasses and grass species associated with disturbance, bare soil, high density of woody plants, soils with higher proportion of silt, higher concentration of P, N, OM, and K. The intermediate zone was characterised by clay soil associated with CEC, Ca, Mg, high proportions of least desirable and intermediate grass species, high herbage mass, and high proportion of woody plants cover. Highly palatable grasses, high score of rangeland condition and sand soil characterised the third zone farthest away from the Pond. It was concluded that distance from the Pond had a significant impact on soil nutrients and, consequently, spatial distribution of herbaceous species and rangeland condition. As proximity to the Pond increased, scores of rangeland condition decreased implying that the Pond contributed to rangeland deterioration. Rangeland degradation may result in local extinction of some plant species and low animal production, finally challenging the livelihood of the pastoral community.

Keywords: Dambi Pond, degradation, distance, soil nutrients, vegetation distribution

Contact Address: Gemedo Dalle Tussie, Institute of Biodiversity Conservation, Forest Genetic Resources Conservation, P.O.Box 80119 Addis Ababa, Ethiopia, e-mail: gemedod@yahoo.com

Implications of Resource Availability and Use for the Economic Success of the Farming Families Settling West of Lake Nasser, Egypt

MOHAMED AHMAD AWAD[1], WERNER DOPPLER[1], RALF SCHLAUDERER[2]

[1]*University of Hohenheim, Farming and Rural Systems in the Tropics and Subtropics, Germany*

[2]*University of Applied Sciences Weihenstephan, Department of Agriculture, Germany*

Egypt is a low-income, food-deficit country with limited arable land and water resources. The national development policies are directed to establish new settlements by extending the cultivated area through desert land reclamation to give farm families a basis for living. Lake Nasser area is a major target for such policies. In this study, the most important resources and factors affecting the economic success of the families are investigated. The results could provide important indications for the successful establishment of a sustainable farming community in the area.

A sample of 100 households was selected using systematic random sampling. Primary data was collected using standardised questionnaire in 2004. The families were classified according to their settling behaviour into three groups: **(a)** permanent families, **(b)** seasonal farmers and **(c)** occasional farmers. A comparative analysis between the groups was applied using the Farming Systems Approach to tackle differences in resource capacities and use as well as families' decision making. Correlation and multiple regression were used to analyse the most important resources and factors affecting the farmers' decision-making.

The analyses results showed that crop cultivation is the most important economic activity in the area. It is capital intensive because most crops require high levels of inputs (fertilisers, manure and pesticides). The far distance of good markets and continuous irrigation problems are important factors increasing cash requirement. Therefore, capital availability is the limiting resource affecting the success of crop cultivation. Other resources such as land, water and labour exert inconsiderable limitations. Although, the area was supposed to attract poor landless families, only farmers with proper access to capital resources are economically successful such as the seasonal farmers. The occasional farmers were the least successful because they don't only have limited capital resources but also limited experience in the cultivation in the area. The seasonal farmers have good access to credit sources particularly informal credit which makes them the most economically successful group. Low input crops were suggested to reduce cash requirement and increase the economic success of poor families.

Keywords: Egypt, farming systems, multiple regression , resource use, socio-economic analysis

Contact Address: Werner Doppler, University of Hohenheim, Farming and Rural Systems in the Tropics and Subtropics, Fruwirthstraße 12, 70593 Stuttgart, Germany, e-mail: doppler@uni-hohenheim.de

The Comparative Advantage of Conservation Agriculture in Wheat and Cotton Rotation in the Khorezm Region, Aral Sea Basin

MEHRIDDIN TURSUNOV[1], IHTIYOR BOBOJONOV[1], JOHN LAMERS[1], ALIM PULATOV[2]

[1]*University of Bonn, Center for Development Research, Germany*
[2]*Tashkent Institute of Irrigation and Melioration, Ecogis, Uzbekistan*

The arable land of Uzbekistan is slowly but steadily deteriorating due to erosion, soil salinity and unsustainable management practices. Water scarcity together with the concurrent shallow groundwater tables are perceived by farmers as major bottlenecks. Sustainable agricultural practices must be developed that increase productivity and improve resource use efficiency. However, measures aiming at improving the ecological conditions cannot be implemented at the expense of the farmers' economic benefits. One promising avenue is the use of soil conservation (SC) practices. We studied the effect of SC agriculture on key environment indicators and on financial gains in Khorezm region in Northwestern Uzbekistan. A long-term field experiment was established on a typical farm-size operational scale (7 ha) on two different soil textures. Cotton and winter wheat production were studied (2004–2005) under four tillage systems: conventional, intermediate (reduced number of tillage operations on the field), permanent bed, zero tillage (no-till). At each of these treatments, the effect of surface mulch was also studied. The development and yield of crops, and also the soil improvement (indicated by soil bulk density, increase in water infiltration capacity, improved organic matter and nutrient availability) were significantly better with the bed-planting system than with planting on flat soil (conventional), especially on the heavy loamy soil. The highest cotton yield was obtained with the intermediate tillage system. The mulch effect was already significant at germination and the initial stage of the crop development; in the end, crop residue cover increased yields of both cotton and wheat significantly irrespective of the tillage system. Water consumption was least with the conservation systems. A financial evaluation showed that permanent bed or intermediate tillage systems had 25–30 % higher gross margins than conventional tillage caused in particular by higher yields, less labour and machinery costs methods. The adaptations of research made the use of SC agriculture principles possible and will improve farmer's profit and livelihood.

Keywords: Crop residue, financial evaluation, gross margin, no-till, permanent beds, soil conservation

Contact Address: Mehriddin Tursunov, University of Bonn, Center for Development Research, Walter-Flex-Str. 3, 53113 Bonn, Germany, e-mail: mehriddin@gmail.com

Regional Forest Issues

Seven Years after the Sfb 308 — Adoption Patterns of Agroforestry Systems in Benin

ANNE FLOQUET[1], MALIKI RAFIOU[2], KAKPO YVONNE[3]

[1]*Cebedes NGO, Benin*

[2]*Institut National des Recherches Agricoles du Bénin, Bénin*

[3]*Université d'Abomey-Calavi, Faculté des Sciences Agronomiques, Bénin*

1986 to 1999 German and Beninese scientists have been working on the development of agroforestry systems in the context of the SFB 308 project. Evolving from alley cropping systems, a large range of designs were experimented on-farm in order to cope with specific labour, cash and competition constraints, including alley farming with *Gliricidia sepium*, live fences with *Senna siamea*, *Cajanus cajan* as a short fallow, *Mucuna* utilis as a cover crop and planted perennial fallow with Acacia auriculiformis. Hundreds of farmers chose one design or more and compared them with their initial farming practices, researchers monitored agronomic and socioeconomic practices; farmers were invited to adjust designs and management practices in order to make as feasible and profitable as possible. On six sites, between 1994 and 1999, 600 farmers set up 800 trials plots.

At the end of the program, national farming systems research teams took over some of the research sites and went on cooperating with experimenting farmers. Some NGOs were invited to promote research results in non experimenting villages.

In 2005, adoption of these systems was surveyed in two southern sites and in R&D central sites. In the South, farmers who had been testing at least one of the technologies between 1994 and 1999 were visited. 65 % of these farmers have been adopting the Acacia planted fallow. Others techniques have been tested but rejected. Adoption depends on profitability and on easiness in setting up the fallow and in marketing fallow products. In the central part of Benin, yam-based alley cropping was adjusted by farmers who reduced shrub density and labour demand of the technology and by researchers who added a cover crop in order improve soil fertility and effects on yam yields. Adoption rate is lower but has not yet reached the plateau of the S-curve.

Even if not every technology developed during the project has been adopted, major changes in the way of conducting research in collaboration with farmers within the national research system were then tested, yielded some successes and still do.

Keywords: Adoption, agroforestry systems, innovation, participatory research

Contact Address: Anne Floquet, Cebedes NGO, 02 Bp 331, Cotonou, Benin, e-mail: uniho@intnet.bj

Scenarios of Land Use and Land Cover Change in Sulawesi: Agricultural Expansion at the Expense of Protected Forests?

MATTHIAS MIMLER[1], JÖRG PRIESS[1], KAMARUDDIN ABDULLAH[2]
[1]*University of Kassel, Center for Environental Systems Research, Germany*
[2]*Institut Pertanian Bogor, Indonesia,*

Globally, the remaining tropical forests are increasingly under pressure. Many forests are subject to different uses, resulting either in a (stepwise) transformation / modification or in a conversion for the establishment of settlements, agricultural land or pastures. At the regional scale, region-specific sets of interacting direct and indirect forces are driving land use and land cover change. In Central Sulawesi, Indonesia, population growth and immigration, a rising interest of local farmers in cash crops, and improved roads influence the demand for agricultural and agro-forestry land. In past decades, forest areas, including protected forests like the Lore Lindu National Park have been shrinking, due to partly illegal forest use (mainly timber and rattan) and forest conversion, during which subsistence crops like rice and cash crops have been planted. In the collaborative research project STORMA ("Stability of Rainforest Margins"), Indonesian-German research groups from different disciplines are investigating the socio-environmental system of the rainforest margins. Studies are conducted in Central Sulawesi, a mountainous research area of 7,500 km^2, with rainforest still being the dominant land cover. Based on recent STORMA results and other sources, we developed different scenarios to study the effects of both large-scale / global driving forces (economy, climate), and regional / local drivers (policy, land-use strategies) on land use and land cover change and the associated socio-environmental impacts. By embedding our regional scenarios into the global scenarios developed for the Millennium Ecosystem Assessment, we achieved consistency with large-scale and global driving forces such as demographic and climate changes, or prices for agricultural commodities. In this study we use the SITE modelling framework to quantify the scenarios. We focus on the question whether and to what extend the changes assumed in different scenarios influence patterns, spatial extend and ecosystem services of agricultural and forest areas, and how forest margins and protected lowland and mountain forests would be affected e.g. in terms of further fractionation.

Keywords: Land use modelling, MEA-compliant scenarios , protected forest, rainforest use and conversion

Contact Address: Matthias Mimler, University of Kassel, Center for Environental Systems Research, Kurt-Wolters-Str. 3, 34109 Kassel, Germany, e-mail: mimler@usf.uni-kassel.de

Participation Behaviour of Indigenous People in Non-timber Forest Products Extraction and Marketing in the Dry Deciduous Forests of South India

PRAKASH SADASHIVAPPA[1], S. SURYAPRAKASH[2], VIJESH VIJAYA KRISHNA[1]

[1]*University of Hohenheim, Department of Agricultural Economics and Social Sciences in the Tropics and Subtropics, Germany*

[2]*University of Agricultural Sciences, Department of Agricultural Economics, India*

The paper examines the role of non-timber forest products (NTFP) in the rural household economy and the demographic and economic factors determining the participation in forest gathering in the dry deciduous forests of Karnataka, South India. It is observed that though the return for labour involved in NTFP extraction and marketing is comparatively higher to the existing wage rate of the primary sector, the labour supply was skewed towards the latter. The average return per day for NTFP could be appreciated by the percent of total labour employed for its gathering and marketing. The average return per day was found to be positively associated with the availability of product in the locality rather than the labour availability for NTFP extraction and marketing. This gives an alarming call on the diminishing NTFP resource in the region. Emphasis on agricultural activity was found to have a bearing on the level of extraction of NTFP. The stagnating agricultural sector would force more households to involve in the NTFP gathering, which could have a hampering effect on the sustainable forest management. Availability of women and child labour played an important role in the participation decision and income generation from forest gathering, while the share of adult members had negative effect on the household getting involved in NTFP gathering. Unit increase in days of employment as hired labour was found to reduce the income and is of great relevance as the Marginal Product was on par with the existing wage rate in the locality. Alternate employment opportunities for the available labour force has significant impact on deciding the extent of NTFP extraction and hence the income generation from it. The relative availability of NTFP in the forest range had significant influence on the income from NTFP gathering. The policies oriented towards sustainable forest management, therefore, ought to take in to consideration of the existing farming patterns and vice-versa. The closely knitted agriculture and forestry sectors calls for a multi-faceted approach for forest management programme, keeping an eye on the development of the farming sector of the locality.

Keywords: Income generation, Participation Decision, Sustainable forest management

Contact Address: Prakash Sadashivappa, University of Hohenheim, Department of Agricultural Economics and Social Sciences in the Tropics and Subtropics, # 254 Ist 'c-Main Kengeri Satellite Town, 560060 Bangalore, Germany, e-mail: prakashsadashiva@gmail.com

Marketing Local Biodiversity in Thailand: Identification of a Possible Good Practice for On-farm Biodiversity Management of Tropical Fruit Trees

FROUKJE KRUIJSSEN[1], SONGPOL SOMSRI[2]

[1]*International Plant Genetic Resources Institute, Regional Office for Asia, the Pacific and Oceania, Malaysia*

[2]*Horticulture Research Institute, Department of Agriculture, Thailand,*

In Asia a rich diversity of approximately 500 species of tropical fruits are important in people's lives by providing a range of livelihood options and contributing to the stability of ecosystems. This diversity is threatened by increased deforestation, indiscriminate harvesting practices and land use conversion. Increasing attention is being given to conserving agro-biodiversity at farm level and in the wild, by creating forward market linkages by processing a range of products of different varieties. Monitoring of sustainable use and management of diversity has been insufficient, especially among perennials. It is therefore necessary to identify a set of good practices that support conservation and sustainable utilisation of diverse tropical fruit species, to understand the situation in which these practices are successful, and to identify their role in terms of responding to pressures urging farmers to switch to modern plant varieties. It is especially important to identify good practices that benefit farmers. Market-based approaches to biodiversity management are considered to have large potential in this area. This paper presents the experience in Thailand, where four farmer or women groups are successfully processing and marketing products derived from native tropical fruit tree varieties. These products are providing income to groups of less than 50 members by procuring their fruits, paying wages for their labour, and distributing profits, and are giving them an incentive to maintain or expand local fruit tree varieties in their homegardens and fields. Groups were established because of unmarketable fruits, due to oversupply or damage caused by storms, have specialised in locally important products, and have received training and financial support from the government. These similarities indicate the factors playing a role in bringing together and empowering these groups, and facilitating the successful marketing of their products. Also some obstacles are identified such as difficulties faced to obtain food safety certificates and lack of attractive packaging and promotion. Although more in-depth research is necessary, important lessons can be learned and tools can be identified that can be tested and implemented for the benefit of farmer income and biodiversity.

Keywords: Biodiversity, good practices, markets, tropical fruits, value addition

Contact Address: Froukje Kruijssen, International Plant Genetic Resources Institute, Regional Office for Asia, the Pacific and Oceania, Po Box 236 Upm Post Office, 43400 Serdang, Malaysia, e-mail: f.kruijssen@cgiar.org

Evaluation of Different Forestry Options to Improve Carbon Content in Rural Communities in Marajo Island, Brazil

NORMA ELY SANTOS, SIEGFRIED BAUER

Justus-Liebig-Universität Giessen, Institute of Agriculture and Food Systems Management, Project and Regional Planning, Germany

Brazilian Amazonia rain forest has suffered changes with high deforestation rates taking place during the past few years. Furthermore, common practices such as slash-and- burn, shifting cultivation and abandonment, can release quantities of greenhouse gases that are significant both in terms of their present impact and in terms of the implied potential for long-term contribution to global warming. Land use change and forestry activities associated to smallholders' traditional practices can affect the local uptake or emissions of carbon by increasing or decreasing the carbon stocks and associated fluxes. Therefore, emissions could be reduced if small agriculturalists adopted better practices or change their land use. In the case of Marajo Island, an area composed of a series of islands geographically constrained but still with a large forest area, environmental services through carbon sequestration appears to be a reasonable alternative for the major part of small farmers which can not integrate the traditional markets and need alternatives for income generation.

A household survey with one hundred households was conducted in Breves and Curralinho districts of Marajó Island. The interviews were oriented to capture the main aspects of the farm households, including agricultural production, forest use and extractives activities. The Cost Benefit analysis was the main tool applied to evaluate the forestry-carbon options selected for the area using as criteria, the net present value and internal rate of return. Further, a sensitivity analysis is employed to simulate different conditions, in terms of interest rates, carbon prices and payment schemes.

The paper discusses selected forestry options to be implemented in the region in order to improve the carbon content and assesses the associated carbon benefits that could emerge in the presence of a carbon trade. Consequently, policy implications for the different options are drawn, including governmental finance support to the first years of the projects and incentives as carbon payments.

Keywords: Carbon , Cost Benefit analysis, forestry activities, greenhouse gas emissions, land use change

Contact Address: Norma Ely Santos, Justus-Liebig-Universität Giessen, Institute of Agriculture and Food Systems Management, Project and Regional Planning, 35392 Giessen, Germany, e-mail: normaelysantos@yahoo.com.br

Animal Sciences

Molecular Genetics and Biodiversity

Insights from FAO's State of the World's Animal Genetic Resources Reporting Process

BARBARA RISCHKOWSKY, DAFYDD PILLING, BEATE SCHERF, RICARDO CARDELLINO, IRENE HOFFMANN

Food and Agriculture Organization of the United Nations (FAO), Animal Production and Health Division, Italy

In 1990, FAO was asked by its governing body to prepare a comprehensive programme for the sustainable management of animal genetic resources (AnGR). In response, the Global Strategy for AnGR management was developed, which is being guided by FAO's Commission on Genetic Resources for Food and Agriculture. Assessment of the status of AnGR management at country level and of methodological tools to support decision-making was considered as an important first step in the programme. The assessment was organised as a country-driven process, where countries were invited to report on AnGR management to FAO. The reporting process included the establishment of a network of National Coordinators and consultative committees, subregional training and follow-up workshops. The process of developing the first report on the State of the World's AnGR was considered as important as the outcome. 169 country reports have now been analysed to assess the countries' situation with regard to the state of livestock diversity, human capacities, current breeding and conservation programmes, use of biotechnology, and legal regulations affecting AnGR management. The diversity in livestock was assessed as number of breeds. Of the reported 7616 breeds 9 % have become extinct, most in Europe, and another 20 % are at risk. Management capacities of countries differ within and between regions. In general, human and institutional capacities in Europe, North America, Australia, and in parts of Asia and Latin America are more developed than in the rest of the world. The global report also analyses scientific methods and tools related to AnGR management. Although the research interest in recent years has increased, there are still large gaps in methods for characterisation, and in defining goals and organisational structures for breeding and conservation programmes in lower input environments. Concerted efforts are needed to prioritise livestock genetic resources for conservation at national, regional and international level. Plant genetic resources have long been acknowledged as part of human heritage, awareness has grown that the same is true for livestock genetic resources. To maintain at least the most precious part of this heritage clearly requires more coordinated efforts.

Keywords: Animal genetic resources, global assessment, livestock diversity

Contact Address: Barbara Rischkowsky, Food and Agriculture Organization of the United Nations (FAO), Animal Production and Health Division, Rome, Italy, e-mail: Barbara.Rischkowsky@fao.org

Awassi Sheep Production and the Development of breeding Program Options in Syria

MOHAMAD YASER AMIN, KURT-JOHANNES PETERS
Humboldt University Berlin, Animal Breeding in Tropics and Subtropics, Germany

The fat-tailed Awassi sheep is the only sheep breed in Syria adapted to the harsh environmental conditions and it is distributed all over the country. There are about 13.5 million heads of Awassi sheep in Syria contributing 78 %, 30 % and 100 % of the total red meat, milk and wool production, respectively. Awassi sheep is the most important livestock animals, grazing on poorly developed wheat and barley fields and on the remains of crops such as wheat and corn. The price of mutton of the Awassi breed, which is in high demand in Syria, was about 35 % higher than beef in 1995. These animals are raised under three husbandry systems (extensive, semi-intensive, and intensive). To improve Awassi sheep the General Commission for Scientific Agricultural Research (GCSAR) in Syria established few stations located across the country. The commission intends to produce specialised lines of animals for milk and meat production. Its target is to distribute those animals to farmers and test the on-farm performance of the shee*p. D*espite this effort, Awassi sheep in Syria produce on average 200—300 kg milk per year compared to Israel, which was able to double milk production (over 500 kg) of its strain through intensive selection. This study aims to analyse breeding objectives and effective breeding programs. During the first step of the study productions systems characterised, breeding objectives determined and local as well as regional breeding activities implemented by sheep producer identified. In a second step the effective of government breeding stations with regard to their impact will be evaluated and alternative breeding programs including a “young ram” scheme analysed in relation to genetic progress and the operational challenges.

Keywords: Awassi, Production, Sheep, Syria

Contact Address: Mohamad Yaser Amin, Humboldt University Berlin, Animal Breeding in Tropics and Subtropics, Phillipstr. 13 Haus 9, 10115 Berlin, Germany, e-mail: yasseramin@hotmail.com

Performance and Fitness Traits Versus Phenotypic Appearance: a Novel Approach to Identify Selection Criteria for Indigenous Breeds

DEO NDUMU[1], ROSWITHA BAUMUNG[1], MARIA WURZINGER[1], ADAM DRUCKER[2], JOHANN SÖLKNER[1]

[1]*BOKU - University of Natural Resources and Applied Life Sciences, Sustainable Agricultural Systems, Division of Livestock Sciences, Austria*

[2]*Charles Darwin University, Australia*

Ankole cattle are well known for their massive white horns and red coat colour. These characteristics are attributed to centuries of cultural breeding practices. Two experiments with traditional cattle keepers were carried out at a governmental Ankole nucleus farm in South-Western Uganda to identify other phenotypic characteristics as well as production and fitness traits which are important indigenous selection criteria. Forty one body measurements, per animal, were taken from 15 bulls and 35 cows and phenotypic characteristics were described in detail. In the first experiment 12 groups of 6 to 8 cattle keepers were invited to rank animals according to their preference for a breeding bull or cow based on phenotype alone. While in the second experiment the ranking was done on the basis of phenotype in addition to a hypothetical history that was randomly assigned to each animal on each day of experiment. The latter history included milk yield (on own performance for cows and that of the dam for bulls), fertility of the animal and its sire as well as resistance to East Coast Fever. For analysis, Generalized Logit Models for Multinomial Logist Models were fitted. To compare different models the likelihood-based pseudo R-square measure was used. The results indicate that, in the selection of cows, performance and fitness traits are emphasised by the cattle keepers. While in the selection of bulls, the phenotypic appearance of the animal itself plays an important role. In cows the animals' milk performance turned out to be the main criterion for higher ranking while in bulls resistance to East Coast Fever was of highest importance. In both sexes a dark red coat colour was highly appreciated. The study portrays the potential usefulness of the methodology in capturing information which can be gainfully employed for an insight into indigenous selection criteria of stock owners else where.

Keywords: Ankole cattle, indigenous knowledge, selection criteria, Uganda

Contact Address: Deo Ndumu, BOKU - University of Natural Resources and Applied Life Sciences, Sustainable Agricultural Systems, Division of Livestock Sciences, Gregor Mendel 33, A-1180 Vienna, Austria, e-mail: dndumu@boku.ac.at

Use of Microsatellites and MtDNA to Assess Genetic Diversity Within and Between Zimbabwe Chicken Eco-types

FARAI CATHERINE MUCHADEYI[1], STEFFEN WEIGEND[2], CLEMENS WOLLNY[3], STANLEY MAKUZA[4]

[1]*Göttingen University, Institute of Animal Breeding and Genetics, Germany*

[2]*Federal Agricultural Research Centre, Institute for Animal Breeding, Germany*

[3]*International Livestock Research Institute, (ILRI), Ethiopia*

[4]*University of Zimbabwe, Department of Animal Science, Zimbabwe*

Village chickens play an integral role in meeting smallholder households social-economic and cultural needs. These local chickens are part of the total poultry biodiversity that is needed to cope with changing production environments, consumer preferences and market demands. The objective of the study was to test whether chickens reared under different climatic and socio-economic factors in geographically distant farming systems differ genetically. Twenty-nine microsatellite markers were typed for 238 individuals randomly selected from the five eco-zones of Zimbabwe. In addition 516bp of the D-loop region of mtDNA were sequenced for 53 chickens from the 5 eco-populations and 60 individuals from broiler and layer reference populations. A total of 238 alleles with an average of 8.41 (SD = 4.729) alleles per microsatellite locus were observed. Gene diversity averaged 0.66 (0.02) while observed heterozygosity was 0.60 (0.01). An average inbreeding coefficient (F_{IS}) of 0.077 (SE = 0.012) was observed across the five eco-populations. Thirteen, 11, 12, 9 and 5 loci contributed to heterozygote deficiency in eco-zone 1-5 respectively. Overall population variation (F_{IT}) was 0.084 (SE = 0.0129), 9 % of which was due to among population variation (F_{ST}). Phylogenetic analysis indicated the Zimbabwe population clustered as one population surrounded by the commercial lines. Fourteen haplotypes were observed from the sequenced mtDNA fragment. Number of haplotypes per population ranged from 1 to 3. The major haplotype with an outgroup weight of 0.22 was found in three Zimbabwe eco-types and 3 commercial lines. The second widely distributed haplotype was unique to 52 % of the Zimbabwe chickens across all the eco-zones. While commercial lines tend to be less polymorphic and do not share haplotypes with other populations, the Zimbabwe chicken eco-types shared some haplotypes among themselves and these reference populations. Results show that the Zimbabwe local chicken population although distributed over a broad geographic range is insignificantly sub-structured and might be sharing a considerable part of their genome with other commercial lines.

Keywords: Inbreeding coefficient, phylogenetic relationship, population structure, poultry diversity

Contact Address: Farai Catherine Muchadeyi, Göttingen University, Institute of Animal Breeding and Genetics, Kellnerweg 6, Göttingen, Germany, e-mail: cmuchad@gwdg.de

Large-scale Transcriptional Analysis of Bovine Oocytes Derived from Growth and Dominance Phases of Follicular Development

NASSER GHANEM, MICHAEL HOELKER, FRANCA RINGS, DANYEL JENNEN, KARL SCHELLANDER, DAWIT TESFAYE

University of Bonn, Institute of Animal Science, Animal Breeding and Husbandry Group, Germany

In previous studies it was indicated that oocytes aspirated at growth phase have higher blastocsyt rate than those aspirated in dominance phase. However, the molecular mechanisms underlying this variation in developmental potential of the oocytes are not well elucidated. So, our objective was to investigate transcriptional activity of bovine oocytes derived from different stages of follicular development. Thirty oestrus-synchronised Simmental heifers were used, and the onset of oestrus was considered as day 0. Ultrasonography-guided ovum pick up was performed to collect oocytes from small follicles (3—5 mm) at growth (day 3) and dominance (day 7) phases of the first follicular wave. BlueChip (2000 clones) cDNA array was used for transcriptional analysis and 10 transcripts were validated by Real-time PCR. Data analysis revealed a total of 51 transcripts to be differentially regulated in the two oocyte groups and 8 out of 10 transcripts were confirmed to be in agreement with microarray results. Oocytes of day 3 were found to be enriched with transcripts involved in protein biosynthesis (RPLP0, RPL8, RPL24, ARL6IP, RpS14, RpS15, RpS4x and RPS3A) or as translation elongation (EF1A), energy production as mitochondrial clones (ATP5A1, FL396 mitochondrion and FL405 mitochondrion), cytoskeleton or chromosome organisation (Actin, beta-Actin, H2AZ and KRT8), calcium ion binding (S100A10 and ANXA2), signal transduction (G-beta like protein) and thiol-disulfide exchange intermediate (TXN). Oocytes of day 7 were enriched with genes involved in cell cycle (CCNB1, CKS2, UBE2D3 and CDC31), transcription factors (MSX1, PTTG1, FANK1 and PWP1), Aldehyde reductase activity (AKR1B1), nucleotide binding (TUBA6 and K-ALPHA^{-1}), growth factor (BMP15), and fertilisation (ZP4). In conclusion, our results showed differences in oocyte transcriptional activity at different stages of follicular development which may explain their differences in developmental competence.

Keywords: Bovine, Follicular development, Gene expression, Oocyte

Contact Address: Dawit Tesfaye, University of Bonn, Institute of Animal Science, Animal Breeding and Husbandry Group, Endenicher Allee 15, 53115 Bonn, Germany, e-mail: tesfaye@itz.uni-bonn.de

Animal Nutrition

Effect of Diet Type on Milk Yield and Composition of Local and Exotic Cattle Breeds Kept in the Coastal Region of Peru

KARIN BARTL[1], MIRIAM GARCIA[2], CARLOS A. GOMEZ[2], HANS–RUDOLF WETTSTEIN[1], MICHAEL KREUZER[1], HANS-DIETER HESS[3]

[1]*ETH Zurich, Institute of Animal Science, Switzerland*

[2]*Universidad Nacional Agraria La Molina, Peru*

[3]*Agroscope Liebefeld-Posieux, Swiss Federal Research Station for Animal Production and Dairy Products (ALP), Switzerland*

The dominant cattle genotypes used by smallholder farmers in the Central Peruvian Andes are the local "Criollo" and Criollo x Brown-Swiss (BS) crossbreds, with an often dominating proportion of BS genes. The response of the two genotypes to three diets with contrasting quality on milk yield and composition was determined in six Criollo and six (almost purebred) BS cows kept in the Peruvian coastal lowlands. Diets represented the quality of typical highland dry-season forage (D), typical highland rainy-season forage (R) and a diet optimised to meet the cows' requirements (O). The diets consisted of different roughages which contained, per kg of dry matter (DM) 40, 76 and 133 g of crude protein, 716, 680 and 519 g of fibre (NDF), and 4.0, 5.4 and 4.8 MJ of net energy lactation (NEL), respectively. Only diet O was complemented with a fixed amount of concentrate. The cows received the roughages ad libitum in a changeover arrangement. The mean yields of energy-corrected milk (ECM, kg/head/day) with diets D, R and O were 1.99, 4.05 and 4.66 for the Criollo and 4.02, 7.01 and 8.77 for the BS cows (effects of breed and diet type; $p < 0.001$). Fat content was not affected by diet type and was lower in the milk of BS (4.63 %) than in the milk of Criollo (5.01 %) cows. In contrast, content of protein was affected by diet quality but not by breed, whereas lactose content was affected by diet quality and by breed. In general, BS cows presented higher absolute increases in ECM production due to improved nutrition than Criollo cows, particularly when switching to diet O (increases of 4.44 and 2.32 kg for BS and Criollo, respectively). However, the relative responses to the different diets were comparable among breeds. This indicates that Peruvian Criollo cows (*Bos taurus*) have the genetic potential to respond to nutritional improvements which contrasts with observations made in a previous study with Boran cows (*Bos indicus*) in Ethiopia.

Keywords: Criollo cattle, dairy production, dry season feeding, milk composition, Peru

Contact Address: Hans-Dieter Hess, Agroscope Liebefeld-Posieux, Swiss Federal Research Station for Animal Production and Dairy Products (ALP), Route de la Tioleyre 4, CH-1725 Posieux, Switzerland, e-mail: dieter.hess@alp.admin.ch

Improving Calf Performance by Supplementation in Bali Cows Grazing Communal Pastures in West Timor, Indonesia

HENDERIANA BELLI[1], I. GUSTI NGURAH JELANTIK[2], WOLFGANG HOLTZ[3]

[1]*University of Nusa Cendana, Department of Animal Production, Indonesia*

[2]*University of Nusa Cendana, Department of Animal Nutrition, Indonesia*

[3]*Georg-August-University Göttingen, Institute of Animal Breeding and Reproduction, Germany*

Two on-farm experiments were conducted in west Timor to investigate the efficacy of strategic supplementation in improving calf performance both during dry and rainy season. In experiment 1, twenty four cow-calf pairs were grouped into three groups of eight pairs with balanced calf sex. They were grazed on communal native pastures for 8 months (control) or supplemented with 1 kg feed supplement consisting of 60 % rice bran and 40 % leucaena plus 100 g urea to Bali cows soon after calving or with 0.5 kg supplement directly to calves started at 2 months of age. Parameters measured included birth weight, milk production, and calf daily gain. In experiment 2, twenty nine one-year old calves were allowed to night grazing (control, n=19) or supplemented with 750 g rice bran (supplemented, n=10) during rainy season. Parameters measured in the experiment 2 included daily weight gain and body measurement. Most calves in experiment 1 were born during June and July and having birth weight varying from 11.4 to 21.5 kg with male calves were significantly ($p < 0.05$) heavier than female calves. Birth weight was relatively unrelated to their dams size but it was well predicted by their body measurements. Daily gain significantly declined ($p < 0.01$) with advancing dry season. Neither supplementation to cows or directly to calves has any significant effect to calves live weight gain and body measurements. Milk production was also unaffected by supplementation. In contrast, live weight gain and body measurements of older calves (experiment 2) were significantly improved ($p < 0.05$) by supplementation of 750 g rice bran during rainy season.

Keywords: Bali calves, body measurements, live weight, strategic supplementation

Contact Address: Henderiana Belli, University of Nusa Cendana, Department of Animal Production, Jalan Eltari II Rt 23 Rw 8 Kelapa Lima, 85228 Kupang, Indonesia, e-mail: heru@kupang.wasantara.net.id

Housefly Maggot Meal (Magmeal): an Emerging Substitute of Fishmeal in Tilapia Diets

JOHNNY ONYEMA OGUNJI[1], KLOAS WERNER[1], MANFRED WIRTH[1], CARSTEN SCHULZ[2], BERNHARD RENNERT[1]

[1]*Institute of Freshwater Ecology and Inland Fisheries, Berlin, Inland Fisheries, Germany*

[2]*Humboldt-Universität zu Berlin, Institute of Animal Science, Germany*

Several feed ingredients have been investigated in an attempt to substitute fishmeal in the fish and livestock diets. These include animal and plant protein sources. Unfortunately attempts to use these ingredients for complete replacement of the fishmeal component in tilapia diets have not entirely been successful. A major reason is the suboptimal content of essential amino acids in the diets especially methionine. Fish growth and feed utilisation are reported to be optimal with proteins of animal origin, mainly fishmeal characterised by being of high nutritive value. However, based on cost effectiveness, availability and crude protein content, housefly larvae seems to be a candidate for replacement of fishmeal in fish diets. In this study a multi-dimensional biological approach was used to evaluate the suitability of House fly Maggot meal as an alternative protein source for Tilapia *Oreochromis niloticus* fingerling. Growth parameters, protein utilisation, carcass composition, stress indicators and haematological parameters were examined. Seven test diets were formulated (Protein content 36 % dry matter; Gross energy 20 kJ/g). Dietary fishmeal concentration, decreased with increasing concentration of magmeal. Amino acid content of magmeal used seemed balanced though slightly lower than the fishmeal. However, it contained higher methionine content than the fishmeal. Fifteen fingerlings (initial weight 2.0±0.1g) were stocked per experimental tank. Experimental diets were fed in triplicates at 5 % body weight in two portions daily. Results show that no significant differences were observed between different feeding groups in terms of fish weight gain (11.25 — 15.08 g), Standard Growth Rate (3.45 — 3.76 % /day), and Food Conversion Ratio (1.05 — 1.22). The mean values for haematocrit, plasma cortisol and glucose were not significantly different ($p < 0.05$) among the feeding groups. This shows that no physiological stressful condition was introduced in the fish by feeding magmeal diets. The observation suggests that magmeal can completely replace fishmeal in the diet of Tilapia *Oreochromis niloticus* fingerling. Magmeal may therefore compare favourably with fish meal in terms of their amino acid profile and can conveniently meet the nutrient requirements of Tilapia *Oreochromis niloticus* fingerling.

Keywords: Alternative protein source, fishmeal, Housefly maggot meal, Tilapia

Contact Address: Johnny Onyema Ogunji, Institute of Freshwater Ecology and Inland Fisheries, Berlin, Inland Fisheries, Müggelseedamm 310, D-12587 Berlin, Germany, e-mail: ogunjijo@yahoo.com

Effect of Variety, Harvesting Stage and Season on the Concentration of Tannins and Alkaloids in Tagasaste (*Chamaecytisus palmensis*)

GETNET ASSEFA[1], CLAUDIA KIJORA[1], KURT-JOHANNES PETERS[1], KAI SONDER[2], MICHAEL WINK[3], NORBERT STEINMÜLLER[2]

[1]*Humboldt-University Berlin, Department of Animal Breeding in the Tropics and Subtropics, Germany*

[2]*International Livestock Research Institute (ILRI), Integrated Natural Resource Management, Ethiopia*

[3]*Heidelberg University, Institute of Pharmacy and Molecular Biotechnology, Germany*

Most browse trees in the tropics contain substantial amounts of secondary metabolites such as phenolic compounds (mainly tannins) and alkaloids. The astringent effect of tannins and the bitter taste of alkaloids accompanied by toxicity generally affect intake and their utilisation by animals. In this study the first experiment evaluates contents of hydrolysable tannins (HT) and condensed tannins (CT) of 65 $^{accession}/_{varieties}$ of tagasaste. The second and third experiments were done on the widely grown variety "MOA" for evaluation of HT, CT and alkaloids. In the second experiment regrowths harvested at 4, 6, 8 and 10 months and separated to growing bud, leaf, bark, branch and stem were evaluated, while In the third experiment leaves harvested during main rainy, dry and short rainy seasons were used.

The leaves of tagasaste accessions tested gave HT and CT in ranges of 16–197 $^{g}/_{kg}$ and 6.9–35.0 $^{abs}/_{g}$ with means of 115 and 12.5 respectively on dry matter basis. In the harvesting stage studies the edible fractions have on average higher HT and CT mainly in the leaves (177.2 $^{g}/_{kg}$ and 20.1 $^{abs}/_{gm}$, respectively) and follow a declining trend as harvesting stage progressed. About 90 % of the alkaloids found in tagasaste were sparteine. High distributions of alkaloids were found in the non-edible fractions, where bark (235 $^{mg}/_{kg}$) was the highest and leaf (40 $^{mg}/_{kg}$) was the lowest. In all fractions, alkaloids increased until the 8th month and declined at the 10th month.

High concentration of HT and alkaloids was found in tagasaste leaves harvested during the rainy seasons compared to the dry season. However, CT was lower during the short rains and dry season and the highest was during the short rains. Generally HT and CT were positively correlated (r=0.25), however, both the HT and CT have a negative correlation coefficient of r=-0.58 and r=-0.69 with alkaloids respectively. The results of this study showed that varietal selection, harvesting management and growing season could be used as a means to control the level of tannins and alkaloids.

Keywords: variety, alkaloids, harvesting stage, season, tagasaste, tannins

Contact Address: Claudia Kijora, Humboldt-University of Berlin, Department of Animal Breeding in the Tropics and Subtropics, Philippstr. 13, House 9, 10115 Berlin, Germany, e-mail: claudia.kijora@agrar.hu-berlin.de

Evaluating the Temporal, Seasonal and Spatial Variation in Nutritive Value of Cactus Pear (*Opuntia ficus-indica*) Using *in vitro* Gas Production and Chemical Analysis Methods

FIREW TEGEGNE, CLAUDIA KIJORA, KURT-JOHANNES PETERS

Humboldt University of Berlin, Institute of Animal Sciences, Germany

Cactus pear (*Opuntia ficus-indica*) is a multipurpose plant of increasing importance in dry areas. A series of three investigations done in northern Ethiopia showed that: **(1)** farmers use cactus as forage, **(2)** it can substitute hay up to 60 % and is a vital water source, **(3)** it is complimentary with urea-treated straw and could partly substitute wheat bran provided straw is urea-treated. Since the feeding trials were done during a dry season at one location this study investigated the seasonal and spatiotemporal variation in chemical composition and in vitro gas production. Three cladodes/pads of three age groups (<1, 1, and >1 years old) from five plants per location (three agro-ecologies) were collected during dry and rainy seasons. *In vitro* gas production test was done according to Menke and Steingaß (1988). Data were subjected to ANOVA using the General Linear Model of SPSS 13.0. Age affected crude protein and crude fibre ($p < 0.001$) but not dry matter (DM) and ash contents ($p > 0.05$). Season affected ($p < 0.001$) all chemical composition parameters except ash content. Location affected ($p < 0.05$) all components except DM content. None of the in vitro degradation parameters were affected by age and season except b and a, respectively ($p > 0.05$). In contrast, location had effects on a and b ($p < 0.001$). None of the factors affected c ($p > 0.05$). Gas production was unaffected ($p > 0.05$) by age and season while location appeared to affect ($p < 0.05$) it at 4 and 48 incubation hours. In conclusion, from the nutritionally important components only crude protein content is affected by age, season and location. Cactus pear could be fed in all cactus-growing zones of the study area year-round but with a strategy that younger cladodes are fed during the dry season.

Keywords: Age, cactus pear, chemical composition, Ethiopia, in vitro gas production, location, season

Contact Address: Firew Tegegne, Humboldt University of Berlin, Institute of Animal Sciences, Philippstr. 13 Haus 9, 10115 Berlin, Germany, e-mail: firewtegegne@yahoo.co.uk

Animal Production Systems

Cattle Management Strategies of Smallholders in the East-african Highlands and their Contribution to Livelihoods

MARIANA RUFINO[1], MARIO HERRERO[2], MARK T. VAN WIJK[1], PABLO TITTONELL[3], KEN GILLER[1]

[1]*Wageningen University, Plant Sciences, The Netherlands*

[2]*International Livestock Research Institute (ILRI), Kenya*

[3]*International Centre for Tropical Agriculture, Tropical Soil Biology and Fertility, Kenya*

Livestock has multiple purposes in smallholder systems. It provides food and income for the household, nutrients to replenish soil fertility and it is a key asset for insurance purposes in times of scarcity. Depending on the importance assigned to these functions, farmers will manage livestock in different ways to suit specific purposes. Given the diversity of strategies that farmers follow, there is a need to evaluate those that contribute the most to farmers' long-term own goals. Seasonal feed availability and quality are considered key constraints affecting the productivity of livestock in crop/livestock systems. These usually follow the rainfall patterns implying that there contrasting body weight changes during the rainy and the dry season. The magnitude of the nutrient transfers at farm scale follows this seasonality. We analysed management decisions that affect both cattle productivity and nutrient management within the farm. We compared intensive dairy systems, with zero-grazing crossbreed cattle with extensive systems with grazing local zebu breeds. We developed a model to analyse long-term effects of management decisions around cattle management, and the consequences in terms of income and its variability. The model includes two components: a simple dynamic livestock model and an organic resources management tool. This integrated model allows the analysis of i) the role of the livestock in terms of nutrient and labour flows, ii) the temporal variability of flows iii) different production systems. An economic balance is included to assess impact of management on livelihoods. Different farmers' objectives around cattle keeping were included in the analysis: 1. Generation of cash through milk production (give priority females with high potential); 2. Cattle as an insurance (prioritise number above productivity) relevant for zebu breeds, and 3. Cattle to provide manure for fertilising crops (feed low quality feedstuffs). Tradeoffs between different objectives arise, e.g. effects of supplementation (using improved legumes) on animal production vs contribution of cattle production to income. There were evident long-term benefits of targeting management groups within a herd.

Keywords: Dynamic modelling, farmers' objectives, fuzzy logic, trade-offs

Contact Address: Mariana Rufino, Wageningen University, Plant Sciences, The Netherlands, e-mail: mariana.rufino@wur.nl

Determinants of Adoption and Diffusion of Fish Ponds in Cameroon

SIMONE KRIESEMER, VOLKER HOFFMANN
University of Hohenheim, Department of Agricultural Communication and Extension, Germany

In face of a growing world population and declining fish stocks through overfishing, aquaculture can play a key role through the provision of high value protein affordable to poor people in developing countries. Yet, the full potential of fish farming is far from being realised in most African countries and the Cameroonian Government continues to import large quantities of fish to satisfy demand. The purpose of this study is to identify perceived driving forces that lead to adoption of fish farming in earthen ponds in Cameroon and inhibiting forces that hamper their sustainability and spread. The underlying theory is Kurt LEWIN'S (1951) psychological field theory in which behaviour is defined as a function of the interaction of the individual and his/her perceived environment. Everet ROGERS' (2003) 'variables determining the rate of adoption' are used as a specific framework. Semi-directive interviews with fish farmers for qualitative and quantitative data collection are used. General patterns of decision-making processes and important driving and inhibiting forces are determined and verified through group discussions. Interviews with local experts give initial thematic and logistic direction and help to critically reflect preliminary results. The expected outcome is the comprehensive understanding of fish farmers' perceptions and the factor combinations that influence their decision-making, based on the model of behaviour modification. This will be achieved through the analysis of fish farming as an innovation taking into account its farmer-perceived attributes and other variables. In particular, its relative advantage will be considered by the comparison of gross margins of alternative income generating activities based on representative farmer cases. The results will be discussed in view of recommendations for future promotion strategies and the role of spatial considerations in designing such strategies.

LEWIN, K. 1951: Field theory in social science. New York.
ROGERS E. 2003: The Diffusion of Innovations. Fifth Edition. The Free Press, New York.

Keywords: Adoption, aquaculture, Cameroon, diffusion, driving and inhibiting forces, fish farming, fish ponds

Contact Address: Simone Kriesemer, University of Hohenheim, Department of Agricultural Communication and Extension, 11900 Bayan Lepas, Germany, e-mail: s.kriesemer@cgiar.org

Sustainable Sheep Breeding Programmes in the Tropics: a Framework for Ethiopia

MARKOS TIBBO[1], JAN PHILIPSSON[2], WORKNEH AYALEW[1]

[1]*International Livestock Research Institute (ILRI), Animal Genetic Resources, Ethiopia*

[2]*Swedish University of Agricultural Sciences (SLU), Animal Breeding and Genetics, Sweden*

Improvement programmes for small ruminants in the tropics face several constraints that have hampered the establishment and sustainability of such programmes. One major shortfall has been weak planning, particularly poor involvement of livestock owners and stakeholders in the design and implementation of the programmes. In sub-Saharan Africa, low productivity, high density of animals in relation to grazing capacity, unreliable rainfall, increasing human population, small landholding, and declining land productivity are all major concerns. Studies in Ethiopia show substantial within and between breed variations, and hence genetic improvement is feasible among indigenous sheep breeds. Different breeding alternatives to maximise production (e.g. lamb growth and survival) per animal while culling less productive animals to reduce flock sizes, and re-allocating of resources (e.g. feed and health management) as a means of upgrading management levels for the genetically superior flocks are suggested. Breeding programmes are proposed to be based on open-nucleus flocks utilising government ranches at the top of a three tier system of flocks. Selection schemes allow an in-flow of high potential breeding ewes from sub-nucleus herds for pure-breeding to nucleus flocks in the ranches. The selected superior rams from the ranches will be distributed to participating farmers in the sub-nucleus flocks for mating. Subsequently village flocks receive selected superior rams from the sub-nucleus herds. The programme is proposed to be managed by a nationally mandated Animal Genetic Resources Institution, which collaborates with research institutions and oversees all activities related to this programme. Such a participatory programme is believed to ensure not only long-term genetic improvement and livelihood improvement, but also conservation of the indigenous genetic diversity as well as eco-system health.

Keywords: Ethiopia, genetic improvement, indigenous sheep, open-nucleus breeding scheme

Contact Address: Markos Tibbo, International Livestock Research Institute (ILRI), Animal Genetic Resources, PO Box 5689, Addis Ababa, Ethiopia, e-mail: m.tibbo@cgiar.org

Characterisation of two Goat Production Systems in the Highlands of Mexico

PHILIPP NAGEL[1], MARIA WURZINGER[1], LUIS IÑIGUEZ[2], FRANCISCO GUADALUPE ECHAVARRÍA CHAIREZ[3], MANUEL DE JESUS FLORES NÁJERA[3], JUAN MANUEL PINOS RODRÍGUEZ[4], WALTER JORGE GÓMEZ RUIZ[4], WERNER ZOLLITSCH[1]

[1]*University of Natural Resources and Applied Life Sciences, Austria*

[2]*International Center for Agricultural Research in the Dry Areas, Syria*

[3]*National Institute of Forestry, Agricultural and Animal Research, Mexico*

[4]*Autonomous University of San Luis Potosí, Mexico*

The aim of this work is to characterise goat production systems in two regions of the Mexican highlands. One study area is located in the state of Zacatecas, where the main production purpose is meat from older kids or adult animals. In the other site which is located in the state of San Luis Potosí, farmers sell young kids and produce milk. The research work focuses on the description of the local Criollo breed, the feeding management of farmers and general socioeconomic aspects. In interviews and participatory workshops, farmers gave valuable information about their production systems and the socioeconomic circumstances which they live in. Body measurements were taken from 100 female goats per region and a phenotypical description was made. In both regions the animals have nearly the same weight, height at withers, chest girth and body length at the age of two years. Older animals in Zacatecas stagnate in weight and at the age of four years goats in San Luis Potosí are 13 kg heavier; in addition, body measurements are seven to nine centimeters greater. Chemical analysis of 43 fodder plants from semiarid rangeland collected during the dry season showed poor nutrient contents. However, some legumes and composites showed reasonable feeding values, although potentially suitable fodder plants sometimes possess defense mechanisms preventing them from being eaten by goats or other animals. Goats graze the whole year on rangeland and additional stubble grazing is common during the dry season. The analysis suggests clear system differentiation: farmers in Zacatecas rely on traditional farming methods and their productive purposes are mixed, while farmers in San Luis Potosí constantly look for new options of farming (i.e. specific feeds, management technologies). Due to this differentiation, which can suggest a different adoption rate, it is likely that the recent improvement efforts in the San Luis Potosí site, could turn into a more entrepreneurial and modern system. This could act as a model for goat production improvement in other Mexican regions.

Keywords: participatory workshop, production system, socioeconomics

Contact Address: Philipp Nagel, University of Natural Resources and Applied Life Sciences, Gregor Mendel Straße 33, 1180 Vienna, Austria, e-mail: philipp.nagel@boku.ac.at

Stated Preferences of Functions of Llama Keeping in Bolivia

ANDRÉ MARKEMANN[1], ANGELIKA STEMMER[2], MARIANNA SIEGMUND-SCHULTZE[3], ANNE VALLE ZÁRATE[3]

[1]*University of Hohenheim, Institute of Animal Production in the Tropics and Subtropics (480a), Germany*

[2]*Universidad Mayor de San Simón, Bolivia*

[3]*University of Hohenheim, Animal Breeding and Husbandry in the Tropics and Subtropics, Germany*

Bolivia accounts for approximately 63 % of the South American llama population. Llamas keep playing an important role in the sustenance of smallholdings in the Andean regions fulfiling various functions in the productive, social and cultural life of the people. However, these functions have not yet been valued scientifically. This study therefore evaluates functions of llama keeping from a breeder's viewpoint. A ranking approach was applied with 75 farmers in 6 villages. The different functions of llama keeping were presented visually. Each farmer was asked to arrange the illustrations according to his personal preference order. The following 10 functions were suggested: i) Means of transportation to cultivated areas, ii) Means of transportation for other purposes, iii) Llama dung as energy source, iv) Sale and/or consumption of fresh/dried meat, v) Sale of live animals for savings, vi) Sale of live animals for emergency purposes, vii) Sale of fibre, viii) Domestic use of fibre, ix) Integration of animals in cultural events/rituals, x) Herd as capital resource. Subsequently, ranking frequencies of stated preferences were calculated (lower values representing higher preferences). Log odds ratios comparing each pair of functions were computed with a multinomial cumulative logit model. The capital function was most important (rank mean: 2.91, standard deviation: 3.11; 14.6 % of total ranking frequency), followed by the transport function to cultivated areas (3.39, 2.05; 13.7 %) and the transport function for other purposes in third place (4.79, 2.95; 10.9 %). Logistic regression analysis indicates that functions were highly significant. Estimated odds ratios showed significant differences for the three highest ranked functions, with the odds of the capital function being 4.65 times the odds of the transport function to cultivated areas ($p < 0.0001$). The odds of the latter were 2.51 the odds of the transport function for other purposes ($p < 0.01$). It was concluded that functions indicating the sale of live animals or fleece (ranked in 7th, 8th and 9th position) were actually not perceived as highly important by the farmers, a fact that has to be taken into account when aiming at the improvement of llama husbandry and breeding.

Keywords: Bolivia, functions of llama keeping, llamas, ranking, stated preferences

Contact Address: André Markemann, University of Hohenheim, Institute of Animal Production in the Tropics and Subtropics (480a), 70593 Stuttgart, Germany, e-mail: markeman@uni-hohenheim.de

GIS, Modeling and Technology

GIS, Modeling and Technology

Future Gis-challenges in Modelling

ANDREAS PRINTZ

University of Stuttgart, Institute for Landscape Planning and Ecology, Germany

We live in a fast changing world. Actually we are confronted with profound changes of our societies as well as with our natural site conditions. Therefore, the estimation of possible future situations and the deduction of adaption strategies are of growing importance for planners and decision
makers. Two important thematic fields for future challenges in GIS (Geographical Information System) modelling are focussed: **1.) Integration of socioeconomic and natural site content** . Most societies nowadays are undergoing a fast and broad transformation process ("globalisation") with fundamental changes in demography, ethical values, technology application, labour management, etc. On the other side environmental conditions ("global climate change") are assumed to be soon changed profoundly. However, socioeconomic and natural sciences often are "introverted" but not able to really communicate with each other as they have different research objects, use different methods and speak different languages. As a result the two research fields often are parallelized but rarely really integrated. To be able to link both discipline fields in a GIS, the challenge is to
establish a defined correlation of socioeconomic characteristics within a certain spatial unit. On a regional level the example of farm types linked
with landscape units is given. **2.) Visions of future spatial patterns** . Possible futures often are sketched in form of scenarios. Mostly, several
scenarios, running over many years, serve to create a database of results within a given (modelling) frame to support decision making in spatial
planning. Thus, there is a growing needs for GIS-based „spatial scenario construction models" (SSCS) that enable the translation of assumed future changes (e.g. in land use) in spatial patterns and time steps. While e.g. the mathematical dimension of a population growth or land use change is
"easy" to calculate on aggregated computations of interest, the spatial distribution of a future population or land use pattern within a larger
region is a very sophisticated affair. Defined push and pull factors can lead to a new assembling of land use classes. The given example illustrates amongst others the development of farmland expansion in Africa (Benin), driven by a strong population growth.

Keywords: Integration, land use classes, spatial distribution

Contact Address: Andreas Printz, University of Stuttgart, Institute for Landscape Planning and Ecology, Grottenau 38, 85356 Freising, Germany, e-mail: apr@uni-stuttgart.de

The Digital Global Map of Irrigation Areas — Development and Validation of Map Version 4

STEFAN SIEBERT[1], JIPPE HOOGEVEEN[2], PETRA DÖLL[1], JEAN-MARC FAURES[2], SEBASTIAN FEICK[1], KAREN FRENKEN[2]

[1]*University of Frankfurt (Main), Institute of Physical Geography, Germany*

[2]*Food and Agriculture Organization of the United Nations, Land and Water Development Division, Italy*

A new version of a digital global map of irrigation areas was developed by combining irrigation statistics for 26909 sub-national statistical units and geo-spatial information on the location and extent of irrigation schemes. The difference to map version 3 (available at: http://www.fao.org/ag/agl/aglw/aquastat/irrigationmap/index.stm) is the incorporation of a map update for Africa, Europe and parts of Latin America. The map shows the percentage of each 5 arc minute by 5 arc minute grid cell (about 86 km^2 along the equator) that was equipped for irrigation around the year 2000. It is thus an important data set for global studies related to land and water, but also for assessments on food security or to quantify possible impacts of climate change on agriculture. The poster describes the data set and the mapping methodology and gives an estimate of map quality at the scale of countries, world regions and the globe. Two indicators of map quality were developed for this purpose, and the map was compared to irrigated areas as derived from remote sensing based global land cover inventories. The main results of the study are, that 278.8 Mio ha were equipped for irrigation at the global scale. About 68 % of the total irrigated area is located in Asia, 17 % in America, 9 % in Europe, 5 % in Africa and 1 % in Oceania. The largest contiguous areas of high irrigation density are found in North India and Pakistan along the rivers Ganges and Indus, in the Hai He, Huang He and Yangtze basins in China, along the Nile river in Egypt and Sudan, in the Mississippi-Missouri river basin and in parts of California. Smaller irrigation areas are spread across almost all populated parts of the world. At the global scale, the overall map quality is good, but there are large regional differences of map quality. It was found that remote sensing based land cover inventories report higher values for the global extent of irrigated land and that there is a need for a systematic comparison of the different data sets.

Keywords: Agriculture, crop management, crop production, global map, irrigation, irrigation map, land cover, land use, water use

Contact Address: Stefan Siebert, University of Frankfurt (Main), Institute of Physical Geography, Georg Voigt Str. 14, 60325 Frankfurt, Germany, e-mail: s.siebert@em.uni-frankfurt.de

Soil Erosion in the Upper Ouémé Catchment (Benin) Considering Land Use and Climate Change — a Modelling Approach

CLAUDIA HIEPE, BERND DIEKKRÜGER
University of Bonn, Geographical Institute, Germany

Soil degradation is a severe problem in Africa. The resulting decline of crop yields threatens food security and forces poverty, migration and land use conflicts. Therefore effective measures against soil degradation are crucial for the achievement of the UN Millennium goals. Prior intervention areas with especially high risks should be identified.
In this study, which is part of the German integrated water resource management project IMPETUS, soil erosion by water has been studied in the Upper Ouémé Catchment (15.000 km^2) in sub-humid Central Benin. Field studies in 2001/02, performed by Junge (2004), revealed that soil loss rates on agricultural fields were 10x higher on fields than on savannah land. Cotton and yam fields were the main contributors. The quantification of soil erosion at the regional scale for longer periods required a modelling approach. The semi-distributed continuous erosion model SWAT (Soil Water Assessment Tool) has been chosen. In 2004 soil transects were studied in order to parameterise a French soil map. For the years 1998 to 2004 the model was successfully calibrated and validated against daily measurements of total discharge and suspended sediment concentration at various outlets in the catchment. Subsequently, the model was applied for different scenarios of climate and land use change until 2025 using spatially explicit results from the regional climate model REMO and the land use/land cover change model CLUE, produced by other IMPETUS members. Land use changes lead to a strong increase in erosion rates, whereas lower precipitation reduced water and sediment yield significantly. Recent and future areas with high erosion risk in the catchment were identified. Based on field observations and farmer interviews in 2005, recommendations for a sustainable soil management are given. In future, the SWAT model shall be combined with the EPIC model to study the effect of agrarian management strategies on crop yield and soil degradation.

Keywords: Africa, Benin, IMPETUS, modelling, soil degradation, SWAT, water erosion

Contact Address: Claudia Hiepe, University of Bonn, Geographical Institute, Bonn, Germany, e-mail: claudia.hiepe@gmx.net

Land Resource Assessment for Social Land Concessions in Rural Cambodia

JAN-PETER MUND[1], VINCENT VAN ENGELEN[2]

[1]*Royal University of Agriculture, Department of Land Management and Land Administration, Cambodia*

[2]*ISRIC - World Soil Information, Netherlands*

The paper presents the application of a land resources assessment method to evaluate biophysical resources,their condition, trends and capability for use in rural Cambodia. The applied geo-ecological method takes into account a range of different agro-ecological factors. Resulting land units are systematic arrangements of various predefined categories. The capability of land units for particular land uses and the adapted treatment required for sustainable landuse avoiding degradation are determined next. Assessments are required to serve the long-term needs of economic and environmental development, land allocation and environmental as well as land management and monitoring. Social concession land for sustainable agricultural purposes will be provided to landless and poor households in Cambodia. Major constraints for agricultural production by poor farmers are limited commercial inputs and a low level of technology implying that unfavourable land or soil qualities are difficult to modify by current farming operations. Qualities to be considered for a suitability rating are e.g. soil fertility, water retention capacity, soil depth, slope and susceptibility to erosion. Landscape and ecological field observations, assembled in a standardised soil and terrain resources database (SOTER) provide the basis for a suitability assessment. A preliminary suitability analysis in two provinces was based on the existing soils map and updated MRC soil data. Additional soil and terrain data was gathered from the digital terrain model SRTM90, the hydrological network as well as land use and land cover pattern derived from Landsat and Spot remote sensing data. Based on 41 auger samples and 10 full pit analyses a soil mapping process on reconnaissance level was started in Oddar Meanchey. Laboratory analyses of field samples have taken place in the Soil lab of the Ministry of Agriculture which probes major physical and chemical soil analysis]. The suitability assessment combines results from soil fertility, water retention capacity, soil depth, slope and susceptibility to erosion, providing five suitability classes according FAO (1974). This derived map provides a quick and comprehensive overview of land resources and conditions for decision makers in the process of land allocation.

Keywords: Cambodia, land resource assessment, Soil Mapping , SOTER

Contact Address: Jan-Peter Mund, Royal University of Agriculture, Department of Land Management and Land Administration, GTZ-Main Office Phnom Penh, P.O. Box 81, Phnom Penh, Cambodia, e-mail: jpmun03@yahoo.com

A Spatial Model of Vegetable Production in Thailand: Results and Policy Implications

BERND HARDEWEG, HERMANN WAIBEL

Leibniz University of Hannover, Development and Agricultural Economics, Faculty of Economics and Management, Germany

In the past decades, vegetable production in Thailand has experienced considerable problems: Increased competition for land and labour from rapid urbanisation and industrialisation has put pressure on traditional peri-urban vegetable production sites. Intensification of the use of external inputs including chemical pesticides and nitrogen fertiliser and the relocation of vegetable production sites to more distant rural areas were some of the consequences. These adjustments on the producer side however were not sufficient to support output growth on par with a growing demand as a result of rapidly rising consumer incomes. Consequently, real prices of vegetables increased with negative implications for the poorer segments of the population. Also consumer safety and food quality is increasingly becoming a concern. The regional programming model presented in this paper addresses these issues by analysing the technological and spatial dimension of vegetable production in Thailand. The model is based on the concept of typical production units and uses cost data elicited by means of expert workshops as well as statistical data on the resource endowments of vegetable farms in Thailand. The model includes supply and demand of 23 vegetable crops disaggregated for 8 regions, 12 periods and different production systems. Positive mathematical programming has been used to calibrate regional supply to baseline data from official production statistics. Results show that on average only 43 % of vegetable demand is satisfied from regional sources. The Bangkok metropolitan region imports more than 80 % of its vegetables from other regions. The impact of increasing fuel prices on the spatial pattern of vegetable production was only moderate. However, improvements in transportation technology result in a significant increase in the share of production areas, where the pressure on natural resources is less severe, which in turn favours less input-intensive production systems. Government policy aiming at reducing over-use of external inputs in vegetable production should therefore encourage the relocation of traditional peri-urban vegetable production to the more developed rural areas.

Keywords: Mathematical programming model, Thailand, vegetable supply analysis

Contact Address: Bernd Hardeweg, Leibniz University of Hannover, Development and Agricultural Economics, Faculty of Economics and Management, Königsworther Platz 1, 30167 Hannover, Germany, e-mail: hardeweg@ifgb.uni-hannover.de

Satellite Based Biomass Estimation on Rangeland in Empedrado, Corrientes - Argentina

DITMAR BERNARDO KURTZ[1,2], JÜRGEN SCHELLBERG[1], MATHIAS BRAUN[2]

[1] *University of Bonn, Institute of Crop Science and Resource Conservation - Crop Production, Germany*

[2] *University of Bonn, Center for Remote Sensing (ZFL),*

The Empedrado department is located in the Northwest of the Corrientes province in Argentina. About 96,692 hectares of the total land area (123,148 hectares) is covered with rangelands usually utilised by continuous grazing. As the stocking rates are visually estimated, resource utilisation is inefficient and produces either overrested or overgrazed areas.

Alternatively, estimation of vegetation cover based on remote sensing data could provide valuable spatial information in support of management decisions as was recently shown in Australia. Since the normalised difference vegetation index (NDVI) derived from satellite imagery is positively related to the standing green biomass, this relationship has been tested for rangelands. The aim of the project was to provide an impartial biomass estimation allowing to support adequate grazing management.

In the present project, five co-registered Landsat 5 TM images (path 226, row 079) from the period 2000 to 2003 were used to calculate NDVI. The imagery had been radiometrically normalised using multivariate alteration detection transformation technique. The historical total dry matter yield (DMY) data, starting in 2000, was checked for completeness and accuracy. Only DMY data coincident with the passing dates of the satellite were used. DMY from three different paddocks and two different vegetation types were analyzed.

Joint analysis of both vegetation types shows a positive relation between NDVI and biomass ($n = 10$ / $r^2 = 0.50$). If compared separately, the relationship was found far better for the highlands than for the lowlands ($n = 6$ / $r^2 = 0.76$; $n = 4$ / $r^2 = 0.18$ respectively). The variation coefficients were between 6 % to 22 % for NDVI and 38 % - 84 % for DMY values. The strong variation is attributed to the fact that historical measurement included not only green biomass but also standing senesced plant material. Furthermore, the lack of sufficient matching dates between DMY and satellite overpasses added to the strong variation among the range of biomass data.

Although the limited repetition rates of the satellite cause considerable restrictions in order to establish accurate pixel-by-pixel biomass estimation, the preliminary results indicate that the general spatial patterns can be captured and incorporated into management scenarios.

Keywords: Dry matter yield, Landsat images, normalised difference vegetation index,

Contact Address: Ditmar Bernardo Kurtz, University of Bonn, Institute of Crop Science and Resource Conservation - Crop Production, Nussallee 1, 53115 Bonn, Germany, e-mail: dkurtz@uni-bonn.de

rangeland, remote sensing

Crops and Soil

Crop Production and Management

Climatic Requirements of Temperate Perennials in Oman

EIKE LUEDELING[1], JENS GEBAUER[2], ANDREAS BUERKERT[2]

[1]*University of Kassel, Institute of Crop Science, Germany*

[2]*University of Kassel, Organic Plant Production and Agroecosystems Research in the Tropics and Subtropics, Germany*

This study was conducted to investigate the climatic conditions favouring the cultivation of temperate perennials in the Jabal Akhdar mountain range of northern Oman, where farmers are successfully growing roses and temperate and subtropical fruits, such as pomegranates, peaches and apricots. In the strongly eroded centre of this range, the oases of Al 'Ayn/Al 'Aqr (1750–1930 masl), Qasha' (1620–1640 masl) and Masayrat ar Ruwajah (1030–1060 masl) are representing a strong altitude gradient, which allows the comparison of cropping systems under different climatic conditions. Temperatures and relative air humidity were measured at 30-min intervals throughout the year, and field areas with their trees were mapped using high-resolution aerial photographs and a Differential Global Positioning System (DGPS).

While mean relative air humidity in all oases was with 37–40 % relatively similar, average annual temperatures strongly varied between sites, ranging from 18.8°C in the upper oases, and 20.8°C in Qasha' to 24.8°C in Masayrat ar Ruwajah. The number of hours below 7°C, important to break a temperate fruit tree's dormancy, was 192 at Al 'Ayn/Al 'Aqr, 88 at Qasha' and 0 at Masayrat ar Ruwajah.

These climatic differences are reflected in the cropping patterns of the three sites. At Al 'Ayn/Al 'Aqr, farmers grow mostly temperate and subtropical perennials, particularly pomegranates (48 % of all perennials) and roses (40 %), while citrus (3 %) and peaches (4 %) are of minor importance. At Qasha', pomegranates (58 %) and roses (13 %) are still present, but peaches (13 %), citrus (5 %) and bananas (3 %) take up larger percentages. At Masayrat ar Ruwajah, the tree layer is dominated by tropical date palm (68 %), which is virtually absent uphill, bananas (15 %) and citrus (12 %). Peaches (2 %), roses (0 %) and pomegranates (0 %) cannot fulfil their chilling requirements and are thus rarely found.

Keywords: Chilling requirement, fruit trees, oasis agriculture, Oman, pomegranate, rose

Contact Address: Eike Luedeling, University of Kassel, Institute of Crop Science, Steinstr. 19, 37213 Witzenhausen, Germany, e-mail: luedeling@uni-kassel.de

Evaluation of Fruit Production in the Mountain Oasis Balad Seed in Northern Oman

JENS GEBAUER, MAHER NAGIEB, ANDREAS BUERKERT
University of Kassel, Organic Plant Production and Agroecosystems Research in the Tropics and Subtropics, Germany

Little is known about the agricultural sustainability of the millenia old mountain oases in northern Oman. The oasis Balad Seet (23.19°N, 57.39°E, 950–1020 m asl) is located in a small valley of the Al-Hajar mountain range and surrounded by limestone cliffs up to 1200 m high.
In this study GIS-based field research on orchards was conducted to investigate the structure and fruit tree diversity. Information about local knowledge and management of the orchards was gathered through farmer interviews.
Overall 15 fruit species and six under-utilised fruit species from 14 families were identified. A total of 2690 date palms (*Phoenix dactylifera* L.) comprising 16 varieties cover 8.8 ha of man-made terraced land. The palm groves are typical agroforestry systems in which the date palms are interplanted with fruit plants such as banana (*Musa x paradisiaca* L.), lime (*Citrus aurantiifolia* [L.] Swingle), papaya (*Carica papaya* L.) and annual crops. In palm groves intensities of inputs such as manure, mineral fertilisers and irrigation water far exceeded outputs of harvests products for N, P and K. The surpluses were 303 kg N, 38 kg P and 173 kg K (ha yr)$^{-1}$. Yields of the 1560 fruit bearing palms strongly depend on the variety and differed from 10 to 100 kg (palm yr)$^{-1}$. High quality irrigation water, the elaborately built soil structure of the orchard terraces and adequate drainage are the main factors explaining the lack of salinisation in this hyper-arid environment.
The data show that fruit production with a total of 3478 plants (395 plants ha^{-1}) is an important component of the oasis agriculture. However, specific horticultural know-how such as clone selection, pruning and grafting seems to be missing. All fruits are consumed by the households within the oasis and none are sold outside. In recent years the number of lime trees in the oasis declined by approximately 75 % due to the rapid spread of the witches broom disease (*Crinipellis perniciosa* [Stahel] Singer).

Keywords: Agroforestry, multilayer vegetation structure, orchard, palm groves, sustainability, under-utilised fruits

Contact Address: Jens Gebauer, University of Kassel, Organic Plant Production and Agroecosystems Research in the Tropics and Subtropics, Steinstr. 19, 37213 Witzenhausen, Germany, e-mail: jgebauer@uni-kassel.de

Grain or Seed? Sorghum Seed Management Practices by Farmers in *Striga* Affected Area of Western Kenya

NETRA BHANDARI[1], MARTHA OPONDO[2], MARIA GERSTER-BENTAYA[1], VOLKER HOFFMANN[1]

[1]*University of Hohenheim, Department of Agricultural Communication and Extension, Germany*

[2]*Kenya Agricultural Research Institute (KARI), KARI-Kibos, Kenya*

Sorghum (*Sorghum bicolor* (L.) MOENCH) is the staple food for millions of people in the semi-arid region of the Sub-Saharan Africa and is popular due to its ability to withstand drought. The parasitic weed *Striga hermonthica* is a major constraint to sorghum production in semi-arid SSA. Yield losses due to *Striga* can be up to 100 %. Striga-resistant Sorghum would be an important component of integrated *Striga* control if resistance was bred into locally adapted Farmers Preferred Sorghum Varieties (FPSVs).

The study was conducted in Kenya in April 2006. The study analyses the existing situation in the sorghum seed sector and the stakeholders' perception on seed and seed management in western Kenya, one of the worst *Striga* stricken regions. Participatory methods were used throughout the study with the aim to obtain information from the participants on indigenous knowledge, cropping systems, seed management and Sorghum seed supply system.

Local sources of seed varied with farmers receiving new varieties of Sorghum through inheritance from their families, gifts and by exchange with relatives and neighbouring farmers as well as from the neighbouring villages. It was established that most farmers have a clear distinction between seed and grain and they carry out specific and deliberate activities to select and preserve seed for sowing. More than 85 % farmers saved their own seed where as 15 % obtained seed from the relatives, neighbours, local markets and sometimes from the government extension services. They select healthy looking panicles before harvest, thresh, dry, treat and store them in a prescribed manner. For various reasons more than 5 % farmers have experienced inability to keep their Sorghum seeds time to time before the sowing season and have had to purchase from traders in the local markets. This factor has contributed a lot to the fluctuation in prices of both sorghum seed and grain throughout the year and sorghum is most expensive during the sowing period.

The study recommends how the *Striga* resistant FPSVs can be integrated into the existing seed supply system either formal or informal.

Keywords: plant breeding, seed management, seed supply system, Sorghum, Striga, Western Kenya

Contact Address: Netra Bhandari, University of Hohenheim, Department of Agricultural Communication and Extension, Schloß, Museumsflügel 120PC, 70599 Stuttgart, Germany, e-mail: bhandari@uni-hohenheim.de

Citrus Cultivation in Kingdom of Saudi Arabia: Contribution and Impact of a New Crop to the Development of 'najran' Area and Other Parts of the Kingdom of Saudi Arabia

ALI AL-JALEEL[1], HASSAN ALI-DINAR[2], GEORG NOGA[3]

[1]*Najran Horticulture Development Research Center in Kingdom of Saudi Arabia, Adminstration, Saudi Arabia*
[2]*Food and Agriculture Organization in Kingdom of Saudi Arabia, Coordination Program,*
[3]*University of Bonn, Institute of Crop Science and Resource conservation - Horticulture, Germany*

Until the late 60th, 'Najran' region in the southern part of Kingdom of Saudi Arabia had only few scattered citrus orchards. During the 70th, interest in growing citrus in the region was sporadic and most citrus cultivars were introduced from Syria, Lebanon and Iraq. However, the real breakthrough came in the early 80th when Najran Horticulture Development Research Center (NHDRC) was established as a pioneer project for development of citrus cultivation in the region. NHDRC immediately launched an ambitious programme to introduce certified citrus cultivars from internationally recognised propagation centres in USA and other parts of the world. Over the years, NHDRC succeeded to provide local farmers with huge amounts of adapted citrus cultivars to the region and other areas of the Kingdom. The impact of this development was particularly felt by Najran locals where huge improvements in farmer's welfare, economy, social life, health and education were attained. The approximate total citrus acreage in Saudi Arabia is 37,500 acres with over 1.5 million trees. Najran region by itself possesses one- fourth of the total acreage. The period has witnessed tremendous research activities in NHDRC to develop the cultivation of this crop in the Kingdom. During the last few years more than 100 different citrus cultivars and rootstocks from all over the world were introduced and evaluated to select the best promising cultivars to Najran region and other parts of the Kingdom. Currently, NHDRC has the capacity to provide farmers annually with 100,000 — 150,000 certified citrus trees. Investment in this crop not only attracted the locals of the region, but other regions in the Kingdom as well. In fact, private companies in the last few years and up to this moment have planted thousands of citrus trees in other suitable areas of the Kingdom. This paper gives an overview of the progress and impact of this crop with the new challenges that need to be resolved to ensure further successful development. It is a successful story of a hard work that turned this part of the Kingdom into a very effective green belt in a desert country.

Keywords: Citrus, desert, development, Kingdom, najran, NHDRC

Contact Address: Ali Al-Jaleel, Najran Horticulture Development Research Center in Kingdom of Saudi Arabia, Adminstration, P.O. Box 337, Najran, Saudi Arabia, e-mail: bstanh@awalnet.net.sa

Modernizing Cashew Culture in Northeast Brazil

SANDRA MARIA GUIMARAES CALLADO, SILKE MEILWES

University of Bonn, Institute of Crop Science and Resource Conservation - Tropical Crop Production, Germany

The cashew tree, *Anacardium occidentale* L., is a typical tropical, perennial tree belonging to the family of the Anarcadiaceae. In Brazil, there are two types of cashewtree: the common one and the anão precoce or early fruit setting. This system is of considerable value in the environmental, agricultural and socio-economic conditions of Northeast Brazil. Northeast Brazil is the main producer with 95 % of the total production spread over 680 thousand hectares of cultivated area. The production is concentrated mainly in the states of Piauí, Ceará and Rio Grande do Norte. According to MEILWES (2006), 70 % of the cultivated area is formed by small producers that possess orchards of 10 ha on average. Currently, 90 % of the total cultivated area of the cashewtree is characterised by the occurrence of the common cultivation type, considered by some experts as the reason of the low productivity of the sector. There are several suggestions to increase the productivity of the orchards, among them, the substitution of the common orchard type with the early fruit setting type (anão precoce). The common type grows up to 12 m, is cultivated in dry conditions at wide spaces of 10×10 m or even 15×15 m and its productivity averages 220 $^{kg}/_{ha}$ of cashewnuts. The "anão precoce", clone CP 76, grows up to 6 m height and produces 1250 $^{kg}/_{ha}$ in dry conditions, and 2500 $^{kg}/_{ha}$ in irrigated areas. This type is cultivated at a spacing of 7×7 m, 7×4 m or 8×6 m. In spite of the better productivity of the "anão precoce", side effects of high density populations are overlooked. It is important to observe that the modernisation of orchards can be, in the short or medium term, an excellent economic decision to provide income to the farmers. But in the long term, several ecological problems could cause decreased productivity in the cashew orchards. The present research emphasises the need to verify some factors, like: soil fertility, salt accumulation in the soil and harvest management. It further points out what is the ecological impact of modernizing cashew orchards in Northeast Brazil.

Keywords: *Anacardium occidentale* L., cashew culture, modernisation, North-East Brazil

Contact Address: Sandra Maria Guimaraes Callado, University of Bonn, Institute of Crop Science and Resource Conservation - Tropical Crop Production, Sechtemer Strasse 29, 50389 Wesseling, Germany, e-mail: scuimara@uni-bonn.de

Cultivation of Yam (*Dioscorea spp.*) and Soil Fertility Aspects in the Kpalimé Region, Togo

VERENA DAMIDA VANDAMME, CHRISTIAN RICHTER
University of Kassel, Institute of Crop Science, Germany

As in many parts of West Africa, yam (*Dioscorea spp.*) is a very important staple food crop in the Kpalimé region of Togo, situated 250 m above sea level with an average temperature of 25°C and 1500 mm rainfall from March until November. As yam has high demands concerning humidity, temperature, and soil fertility (pH, structure, nutrients), its cultivation by farmers can serve as an indicator for high soil fertility.
The aim of our investigation was to describe farmers' possibilities to overcome the decline in soil fertility which takes place due to a growing population and therefore shorter time of fallow period in the shifting cultivation system. Therefore yam growing farmers in the region of Kpalimé were interviewed concerning their methods of growing yam as to rotation, field preparation, cultivation, harvest, and nutrient balances (plant residues and fertiliser application). On the same farms soil samples were taken and analysed concerning texture, organic matter (C, N), pH, and plant available nutrients. Our results show that in the Kpalimé region, after clearing by slash and burn, yam is cultivated only in the first year. The fields are not fertlized, as farmers can not afford fertilisers and fertiliser transport is difficult. Soil analyses showed that the content of organic matter is medium (2.2–3.1 %), but that these (loamy) soils are too acid (pH (0.01 m calciumchloride)4.1–5.6) and their contents of plant available P (0.7–1.5 mg P-CAL/100 g) and ammoniumacetate exchangeable K (0.16–0.29 cmol(+)/kg) are too low for high yields.
To ameliorate soil fertility in the yam fields of Kpalimé, it is recommended to fertilise, e.g. with organic fertilisers (farmyard manure, compost etc.), in order to apply P and K and other nutrients; to replace natural fallow by controlled green fallow with legumes and to intensify legume cultivation; and to incorporate plant residues into the soil instead of burning them in order to avoid losses of organic matter with C, N and S.

Keywords: Soil fertility, Togo, yam

Contact Address: Christian Richter, University of Kassel, Institute of Crop Science, Steinstraße 19, 37213 Witzenhausen, Germany, e-mail: chricht@wiz.uni-kassel.de

Optimising Cotton (*Gossypium Hirsutum* L.) Fertilisation in the Irrigated Agriculture of the Aral Sea Basin in Uzbekistan

KIRSTEN KIENZLER[1], NAZAR IBRAGIMOV[2], JOHN LAMERS[1], PAUL L. G. VLEK[1]

[1]*University of Bonn, Center for Development Research (ZEF), Department of Ecology and Resource Management, Germany*

[2]*Cotton Research Institute, Uzbekistan*

Cotton (*Gossypium hirsutum* L.) had and still has a central role in Uzbekistan's economic development. Up until now, cotton is grown as state order crop where production targets are set by the government. Due to heavy input subsidies during Soviet times, unsustainable agricultural practices like over-use of fertilisers was common, and farmers had no incentives to efficiently use fertilisers, pay attention to losses to the environment, or consider cost-effectiveness of their management.

Given the on-going reforms after independence, i.e. increasing privatisation, farmers need adapted fertiliser management recommendations. Most fertility research conducted by the Uzbek Cotton Research Institutes, however, aimed at maximising cotton production. The last update occurred before independence and did not consider factors such as cotton quality and cost-effectiveness of fertiliser use. As a result, the former fertiliser recommendations do not meet the new economic demands.

Therefore, the response of irrigated cotton to different N, P and K-fertiliser rates was studied on a slightly saline soil in Khorezm region, in North-western Uzbekistan. Cotton yield, quality, nutrient balances and the economic feasibility of fertilisation rates were determined. Results showed that higher NPK rates and balanced proportions of N:P:K increased cotton yields while concurrently improving its seed and fibre quality. The quality depended highly on the time of picking and showed an optimum at the first pick. However, higher application rates negatively affected potential income of farmers. An increase in fertiliser rate increased total yield and profits but also delayed the opening of cotton-balls, which then did not coincide any more with the period when the highest cotton price was offered by the ginneries. Hence, the rate of return to investments was highest for lower fertilisation rates.

The findings suggest that the present fertiliser recommendations are inadequate for increasing the yield and quality of Uzbek cotton and simultaneously increasing farmers' income and livelihood. Instead, recommendation windows should be implemented which allow to consider various aspects, and on which private farmers can make their own decisions depending on their priorities and interests.

Keywords: Cotton, fertiliser, quality, rate of return, yield

Contact Address: Kirsten Kienzler, University of Bonn, Center for Development Research (ZEF), Department of Ecology and Resource Management, Walter-Flex-Straße 3, 53113 Bonn, Germany, e-mail: kkienzler@uni-bonn.de

Cowpea (*Vigna unguiculata*) for Leafy Vegetable Use in Malawi: Agronomic Evaluation on Station and on Farm

CHARLES MALIDADI, BRIGITTE L. MAASS

Georg-August-University Göttingen, Department of Crop Sciences: Agronomy in the Tropics, Germany

Among African leafy vegetables, cowpea is one of the highly appreciated according to comprehensive surveys from four African countries conducted within the collaborative project 'Promotion of Neglected Indigenous Vegetable Crops for Nutritional Health in Eastern and Southern Africa' (ProNIVA). However, cowpea leaf for vegetable use has been neglected in research and development. The objective of this research was to improve the use of cowpea as a vegetable under Malawi conditions. Ten cowpea accessions were selected following agronomic evaluation and assessment of consumers' acceptability in collaboration with The World Vegetable Center's Regional Center for Africa (AVRDC-RCA) in Tanzania. Most important properties for selection were leaf and grain yield, seed colour, and acceptability to consumers. Two local varieties, 'Nseula' and 'Khobwe', as well as 'Sudan', the variety recommended by the extension service in Malawi, were taken as local checks. Agronomic evaluation was conducted under rain-fed conditions at Bvumbwe Agricultural Research Station and on farmers' fields in two villages, Kankhomba and Tomasi, of southern Malawi during six months of the 2005/2006 crop growing season. Leafy vegetable and seed yields as well as key features of nutritional quality were determined. High variation in leaf yield was determined over three consecutive harvests. Most of the accessions previously selected in Tanzania had high leaf yields, similar to 'Khobwe', but superior to the other checks. Seed yield also differed among accessions. Three selected accessions together with 'Sudan' had higher seed yields. The on-station trial gave leaf and seed yields substantially higher than the on-farm trials. However, there were differences between the two villages, with Kankhomba generally giving higher yields than Tomasi. Leaf and seed nitrogen contents were substantially higher for four selected accessions together with 'Khobwe'. Farmers indicated they would prefer rather early-maturing varieties, which combined both high seed and leaf yields because they value the dual use of cowpeas.

Keywords: African vegetables, genetic resources, leafy vegetable, Malawi, on-farm evaluation, underutilised crops, *Vigna unguiculata*

Contact Address: Charles Malidadi, Georg-August-University Göttingen, Department of Crop Sciences: Agronomy in the Tropics, Grisebachstr. 6, D-37077 Göttingen, Germany, e-mail: charlesmalidadi@yahoo.com

Diversity in Nutritional Quality of Cowpea (*Vigna unguiculata*) and Lablab Bean (*Lablab purpureus*) as Leafy Vegetables

JEREMIAH MAGESA[1], RAY-YU YAN[2], BRIGITTE L. MAASS[1]

[1]*Georg-August-University Göttingen, Department of Crop Sciences: Agronomy in the Tropics, Germany*

[2]*AVRDC (The World Vegetable Center), Nutrition and Analytical Laboratory, Taiwan*

African indigenous vegetables play a significant role in maintaining the nutritional well-being of the rural population in Sub-Saharan Africa. They may cover the daily requirements of proteins, minerals and vitamins because of their great nutritional value. These vegetables are also an important sector for employment and can provide cash income for resource-poor farmers due to their short production cycles and relatively little management required in cultivation. This study aims at assessing nutritional variation among genotypes of cowpea and lablab bean for vegetable use, following agronomic evaluation and assessment of consumers' acceptability of the same germplasm in collaboration with The World Vegetable Center's Regional Center for Africa (AVRDC-RCA) in Tanzania. This research was carried out in a greenhouse at University of Göttingen within the collaborative project 'Promotion of Neglected Indigenous Vegetable Crops for Nutritional Health in Eastern and Southern Africa' (ProNIVA). To further assess nutritional quality of these species, 41 cowpea and 20 lablab bean genotypes were evaluated. Young leaves from plants grown in the greenhouse under semi-controlled conditions were used as well as young leaves from plants grown in pots under sunlight conditions. The latter was performed with selected genotypes in order to observe their response to outdoor conditions regarding nutritional quality. Leaf samples were freeze-dried, oven-dried or sun-dried. Standard laboratory procedures, such as Near Infrared Reflectance Spectroscopy (NIRS), High Performance Liquid Chromatography (HPLC) and Atomic Absorption Spectrophotometry (AAS) were applied to determine nitrogen, vitamin A, and minerals. The collected data was subjected to correlation analysis to determine interdependence of traits. Multivariate statistics were also applied for establishing groups of genotypes that have similar combination of traits. Results from this research have shown that environments had stronger effects on nutrient composition than accessions or species. This draws attention on the need to standardise environmental factors for the search of qualitatively promising genotypes.

Keywords: Atomic Absorption Spectroscopy, African vegetables, genetic resources, HPLC, *Lablab purpureus*, NIRS, underutilised crops, *vigna unguiculata*

Contact Address: Jeremiah Magesa, Georg-August-University Göttingen, Department of Crop Sciences: Agronomy in the Tropics, Grisebachstr. 6, D-37077 Göttingen, Germany, e-mail: jeremagesa@yahoo.com

Antioxidant Capacity and Bioactive Compounds of Tomato Varieties as Affected by Processing Method

ANNIA GONZALEZ RIVERO[1], ANNA KEUTGEN[1], ELKE PAWELZIK[2]
[1]*University of Göttingen, Crop Science, Germany*
[2]*Georg-August-University Göttingen, Institute of Agricultural Chemistry, Germany*

In recent years, the agri-food sector and consumers have begun to look at food not only for basic nutrition, but also for health benefits. An increased interest in tomato and its products has been created by the fact that their consumption has been correlated with a reduced risk of some types of cancer and cardiovascular disease, possibly due to the content of some bioactive compounds.
The purpose of this study was to investigate the variations in the contents of the antioxidants: lycopene, ascorbic acid and phenolics, and their contribution to the antioxidant activity in nine selected tomato genotypes from Cuba and Germany, which differ in colour, size and shape. Furthermore, the nutritional stability of tomato products was assessed after the different processing methods as freezing, concentration to obtain puree, and ketchup production.
Significant differences were found between lycopene, ascorbic acid, total phenolic content and total antioxidant capacity among the various genotypes and processing methods. There was a significant reduction in the ascorbic acid content for the processed samples, compared with the frozen, with the highest values for Goldene Königin (GK), Yellow Pearshaped (YP) and Rilia (CRi). There was a remarkable increase in lycopene levels of puree, compared with frozen and ketchup. CRi, Suso F1 Hybride (SR), Vyta **(V)** and CIMA (C) had the highest content of lycopene in all processing methods. Significant differences were found in the phenolic content of frozen, puree and ketchup. The lower values corresponded to frozen samples and the highest to ketchup. GK, SR, V and C showed the highest concentration of phenolic compounds in all the processing methods. Roma (CRo), CRi and Campbell-28 (CC) had highest content of lycopene and phenolic compounds only in the processed products. Total antioxidant capacity of all cultivars increased in the processed samples, with the highest values for the ketchup. The best tomato product according to the antioxidant capacity was ketchup.

Keywords: Antioxidant capacity, bioactive compounds, processing methods, tomato

Contact Address: Annia Gonzalez Rivero, University of Göttingen, Crop Science, Albrecht thaer-weg 20-C, 37075 Göttingen, Germany, e-mail: anniagr76@yahoo.es

Medicinal Natural and Agricultural Ecosystems Exploitation in Latin America

ISABEL MARIA MADALENO

Tropical Institute, Department of Natural Sciences, Portugal

As science and culture go global, accompanying a global economy, tensions ravage small communities nearly everywhere for basic needs such as food, shelter and health are frequently not met and prosperity is unevenly distributed. The paper addresses one of those basic human needs and rights — health — focusing alternative medicinal practises and predominantly medicinal herbs production, trade and consumption in Latin America, seen as a fair usage of local plant resources by local actors, under ancestral Indian healing traditions aimed at lower income urban households. Research undertaken in four cities, different in size (2 up to 17 millions) and location (North and South America) has shown there are market niches for alternative medicinal trade, income generation at small scale being a fact, and medicinal agricultural ecosystems being sustainable either in rural, periurban, even urban environments. The herbs, fruits, roots, etc. traded and consumed in urban markets come from diverse locations ranging from rainforests to mountainous milieus: 1. Lower and upper Amazonia (Brazil and Peru); 2.Plateaus and Andean high plateaus (Peru and Chile); Forested volcano slopes (Mexico, Peru and Chile); 3.Peri-urban valleys (Chile) and season flooded planes (Brazil). Some plant species are wild and collected under demand, but most of them are grown in peri-urban and rural areas, using less than one-hectare plots and no chemicals at all. Medicinal herbs trade field researched in Lima (Peru), Santiago (Chile), Belen (Brazil) and Mexico City (Mexico), depicts a sustainable use of local and national natural and agricultural resources, whereas targeting lower income populations, contributing to decrease health risks and therefore addressing the issue of poverty in a globalised world.

Keywords: Medicinal plants, Latin America, ecosystems

Contact Address: Isabel Maria Madaleno, Tropical Institute, Department of Natural Sciences, Rua Andrade, 8-2ºe, 1170-015 Lisbon, Portugal, e-mail: isabel-madaleno@netcabo.pt

Gamma Oryzanol Content in Local Genotypes of Purple Rice from Thailand

PANITA BOONSIT[1], DUMNERN KARLADEE[1], PUNTIPA PHONGPIACHAN[2]
[1]*Chiang Mai University, Agronomy, Thailand*
[2]*Chiang Mai University, Animal Science, Thailand*

Gamma oryzanol is an unsaponifiable component of rice oil, composed of several kinds of ferulic acids and has an effect similar to vitamin E in human health. Previous research has concentrated on the content in the rice bran, which is not useful in human diet. In this research, objective was to determine the content of gamma oryzanol in the unpolished rice grain. Ten purple rice and two white rice genotypes were experimented. Three replications of RCBD were designed in the field experiment. Grains of purple and white rice genotypes from each replication were milled as unpolished giving purple rice grains and brown rice grains respectively. Crude oil was extracted from this purple and brown rice grains using n-hexane and ethyl acetate. The content of semi purified gamma oryzanol and gamma oryzanol were analysed using a reverse-phase HPLC column of ODS C18. The results show that the contents of crude oil extracted from brown rice grains of the white rice genotypes did not differ significantly from the contents extracted from purple rice grain of the purple rice genotypes. The overall mean was 2.60 g/100g grain. This led to the correlation coefficient of crude oil to semi purified gamma oryzanol and gamma oryzanol to be non significant. The differences among the contents of semi purified gamma oryzanol were significant, as were the differences among the contents of gamma oryzanol. The higher content of gamma oryzanol was found in two purple rice genotypes. These two genotypes exhibited also a higher semi purified gamma oryzanol content. While the purple rice genotypes with a lower gamma oryzanol content exhibited also a lower semi purified gamma oryzanol, one of the white rice genotype (KDML105) also showed a lower gamma oryzanol, exhibited semi purified gamma oryzanol among the higher group. The relationship, however, between these two characters was still significant. Comparison of the three characters between the two rice groups indicated that the purple rice group exhibited a higher mean of gamma oryzanol content than the white rice group mean.

Keywords: Brown rice grain, Gamma oryzanol, Purple rice grain

Contact Address: Panita Boonsit, Chiang Mai University, Agronomy, 239 Heuy Khaew Rd., 50200 Chiang Mai, Thailand, e-mail: panita@chiangmai.ac.th

Allelopathy in the Tropical Forage Grass *Brachiaria brizantha*

REBEKKA POHL, ELKE FISCHER, RAINER SCHULTZE-KRAFT
University of Hohenheim, Institute of Plant Production and Agroecology in the Tropics and Subtropics, Department of Biodiversity and Land Rehabilitation, Germany

Species of the tropical genus *Brachiaria* are widely used in improved pastures. Field observations with the particularly widespread *Brachiaria brizantha* cv. Marandu indicate that it can be difficult to establish and maintain mixtures with a legume. Furthermore, in grass-only pastures complete lack of seedling recruitment has been observed. A reason for both phenomena could be allelopathy.

To elucidate the allelopathic potential of *B. brizantha* cv. Marandu in comparison with three other *Brachiaria* cultivars of current economic importance, *B. brizantha* cv. Toledo and the *Brachiaria* hybrids Mulato and Mulato II, two laboratory bioassays were conducted with aqueous extracts, in different concentrations, from **(1)** leaves and **(2)** roots of the four cultivars, testing their effect on **(1)** the grasses themselves (autotoxicity test) and **(2)** three forage legumes, *Leucaena leucocephala*, *Desmodium ovalifolium*, and *Pueraria phaseoloides*.

The autotoxicity test showed germination inhibition and a retarded seedling growth in the treatments with cvv. Marandu and Toledo. This could be caused either by allelopathic effects or the high osmotic potential of the extract solution. In the test with the legumes, aqueous leaf extract of cv. Marandu showed faint but not significant effects such as germination inhibition, reduced weight and root length of seedlings of D. ovalifolium and *L. leucocephala*. In contrast, low concentrations of cv. Marandu extract had beneficial rather than harmful effects on seedling growth of *L. leucocephala*. Similar observations of growth stimulating effects of allelochemicals in low concentrations are reported for other species.

The findings confirm the allelopathic potential of *Brachiaria brizantha* cv. Marandu. However, further research is needed to elucidate the complex issue of allelopathy within the genus *Brachiaria*. Such research should include **(1)** work in pastures where alleged allelopathy has been observed as well as **(2)** a comprehensive participatory survey in order to complement the rather anecdotic information available so far.

Keywords: Allelopathy, *Brachiaria*, Forage grass

Contact Address: Elke Fischer, University of Hohenheim, Institute of Plant Production and Agroecology in the Tropics and Subtropics, Department of Biodiversity and Land Rehabilitation, Garbenstr. 13, 70599 Stuttgart, Germany, e-mail: fischere@uni-hohenheim.de

Characters Association and Path Coefficient Analysis of Yield and Some Yield Components in Sesame (*Sesamum Indicum* L.)

IBRAHIM M. SEIFELDIN[1], MOHAMED OSMAN KHIDIR[2]

[1]*University of Bonn, Department of Crop Science and Plant Breeding, Germany*

[2]*Faculty of Agriculture, University of Khartoum, Department of Agronomy,*

Two hundreds and twenty F5 families derived from ten sesame crosses and advanced by the single seed descent (SSD) method were evaluated at the Demonstration Farm, University of Khartoum, Shambat, Sudan, for two consecutive seasons (1998/99 and 1999/00), using nested design with three replications. Data were collected on 10 characters in 10 randomly selected plants. Genotypic associations between 10 characters and direct and indirect effects of plant height, number of capsules/plant, number of primary branches, number of seeds/capsule, 1000-seed weight and on seed yield/plant were estimated.

Highly significant positive genotypic associations were detected for seed yield/plant with seed yield/ha and for each of them with plant height, number of capsules/plant, number of primary branches, height to first capsule, days to 50 % flowering and days to maturity as well as number of capsules/plant with number of primary branches, days to 50 % flowering and days to maturity; plant height with height to first capsule and days to maturity; and height to first capsule with number of capsules/plant, number of primary branches and days to 50 % flowering. On the other hand, significant negative genotypic associations were recorded for 1000-seed weight with number of capsules/plant and number of primary branches. However, significant negative genotypic associations were detected for number of seeds/capsule with number of capsules/plant; number of primary branches with plant height and number of seeds/capsule. For the rest of character combinations, there were different patterns of associations within and over seasons.

Path analysis revealed that number of capsules/plant had the highest positive direct effect (0.804) on seed yield/plant, followed by the 1000-seed weight (0.314) and then the number of seeds/capsule (0.284). On the other hand, the number of primary branches via the number of capsules/plant gave the highest positive indirect effect (0.555) on seed yield/plant, followed by plant height also via the number of capsules/plant. However, the highest negative indirect effect (-0.199) on seed yield/plant was exhibited by the 1000-seed weight through number of capsules/plant.

Keywords: Crosses, direct and indirect effects, F5 families, genotypic association, sesamum indicum L., single seed descent (SSD) method

Contact Address: Ibrahim M. Seifeldin, University of Bonn, Department of Crop Science and Plant Breeding, Katzenburgweg 5, 53115 Bonn, Germany, e-mail: ssdmaster@hotmail.com

Mixed Cropping Organic Farming

Economic Feasibility of Small Scale Organic Production of Rice, Common Bean and Maize in Goias State, Brazil

ALCIDO ELENOR WANDER[1], AGOSTINHO DIRCEU DIDONET[2], JOSE ALOISIO ALVES MOREIRA[2], FABIO PIRES MOREIRA[2], ANNA CRISTINA LANNA[2], JOSÉ ALEXANDRE FREITAS BARRIGOSSI[2], ELIANE DIAS QUINTELA[2]

[1]*Brazilian Agricultural Research Corporation (EMBRAPA); Federal University of Goias (UFG); Faculdades Alves Faria (ALFA), Brazil*

[2]*Brazilian Agricultural Research Corporation (EMBRAPA), National Rice and Beans Research Center (CNPAF),*

The increasing demand for healthy food and the need for environmental and economic sustainability of agricultural production are promoting organic farming worldwide. Therefore, agricultural researchers are challenged to develop such systems together with the stakeholders. In Brazil, scientists are testing different farming systems to produce organic food. However, the economic feasibility, which is a key factor for technology adoption and sustainable production, has not being analysed so far. This paper assesses the economic feasibility of small scale organic production of rice, common bean and maize in Goiás State, Brazil. During 2004/05 and 2005/06 growing seasons, rice, common bean and maize were produced at the organic farm of Embrapa Rice and Beans under five mulching systems, with and without tillage. All carried out operations and used inputs were recorded. Based on those records, the production costs for each crop were estimated in each cropping seasons. The costs include operations like seeding, dissecation, ploughing, harrowing, spraying and harvesting, as well as inputs like seeds, inoculates, neem oil and organic fertilisers. The benefits include the gross revenue obtained by multiplying the production amount with the market price for non-organic products. For the purpose of analysis of competitiveness of organic production in comparison to conventional farming the market prices assumed were those of conventional production. In the analysis, the costs of certification were not considered yet due to lack of certifiers in the region. For comparison between traits, the benefit-cost-ratio (BCR) was used. In 2004/05 growing season the BCR varied from 0.27 for common bean on sorghum mulch system with tillage up to 4.05 for green harvested maize produced after Crotalaria in no tillage system. Common bean and rice were not economically viable in this growing season. In 2005/06 growing season the BCR varied between 0.75 for common bean after sorghum in tillage system and 4.50 for green harvested maize produced after fallow in no tillage system. In this season common bean was economically viable in leguminous mulching systems and green harvested maize was viable in all mulching systems.

Keywords: Benefit-cost-ratio, organic farming, production costs, smallholder production

Contact Address: Alcido Elenor Wander, Brazilian Agricultural Research Corporation (EMBRAPA); Federal University of Goias (UFG); Faculdades Alves Faria (ALFA), Rodovia Goiania a Nova Veneza, km 12, 75375-000 Santo Antonio de Goias, Brazil, e-mail: awander@cnpaf.embrapa.br

Examining the Micro-level Sustainability Status of Conventional and Organic Rice Farming Systems of Coastal Kerala, India

DEEPESH PUTHIYAPURAYIL CHANGAT[1], VIJESH VIJAYA KRISHNA[2], S. SURYAPRAKASH[3], SETHULEKSHMI KUMBALATH RAJAGOPAL[4]

[1]*Humboldt Unversity Berlin, Department of Agricultural Economics and Social Sciences, Germany*
[2]*University of Hohenheim, International Agricultural Trade and Food Security, Germany*
[3]*University of Agricultural Sciences, Department of Agricultural Economics, India*
[4]*Kerala University, Thiruvananthapuram, University Library Research Centre, India*

Agricultural sustainability has been defined as the ability of the farming system to maintain its productivity and utility indefinitely. The present study attempts to analyse the microlevel sustainability status of conventional and organic rice farming systems of Coastal Kerala (India), and evaluates the structural differences existing between the sustainable and unsustainable farms. Two farming systems were selected for the study — Kuttanad for conventional and Pokkali Lands for organic rice farming. The sustainability analysis comprises of formation of an index, taking following indicators into account: (i) economic (gross income per hectare and benefit-cost ratio) , (ii) energy (net energy efficiency, net economic productivity of energy, and net energy productivity of capital), (iii) farming (fertiliser productivity and pesticide productivity), and (iv) environmental (cost of nitrate pollution and cost of pesticide pollution). This Multi-Criteria Approach manifested that the micro-level sustainability shows wide degree of variation depending mainly on the personal characteristics of cultivator. The farms were classified into sustainable and unsustainable categories and input use across them was compared. Organic farms having larger operational area were showing higher level of sustainability. The increasing global concern over environmental protection and human health problems caused by agrochemical residues in food and environment and the resulting raise in demand for organically produced commodities assures brighter future for such systems. Despite rice cultivation being not profitable under the organic farming, the overall farming system is made highly profitable by including prawn cultivation in the succeeding season. A case-study is followed, examining the sustainability status of rice cultivation practices of Kaippad system of Kerala, where rice is grown in marshy lands and considerable share of cultivation practices are indigenous. Similar to the Pokkali farming, this system also depend fully on the organic farming measures. The case-study results also indicate that human resources, like information availability and education status of farmers, are the major determining factors of micro-level sustainability.

Keywords: India, Multi criteria approach, Organic farming, rice cultivation

Contact Address: Vijesh Vijaya Krishna, University of Hohenheim, International Agricultural Trade and Food Security, 70593 Stuttgart, Germany, e-mail: vkrishna@uni-hohenheim.de

Perspectives of Organic Farming in the Ucayali Region of Peru - Institutional Approach

JANA LOJKOVA, BOHDAN LOJKA, JAN BANOUT, ZBYNEK POLESNY, DANIEL PREININGER

Czech University of Agriculture, Institue of Tropics and Subtropics, Czech Republic

Organic agriculture in the Ucayali region is more then 10 years a stagnated sector. Organic certification and marketing of organic products are absent here. The study is focused on the state of the art of organic agriculture in the study area from point of view of institutional economy and evaluating the social capital in the communities is looking for the answer of stagnation of organic agriculture in the region. Semi-structured interviews and PRA monitoring were used to collect the field data in the six different chosen communities, near Pucallpa, the capital of the region. Contacting of key informants of organic agriculture in Peru by questionnaire was also used and on the base of this information the actual state of organic agriculture in the region was evaluated, like the size of available and used areas, marketing of the products and the major problems of the agricultural systems in the area. To describe the actual situation, case study of organic product unit is presented in the study and its certification cost and evaluation of marketing possibilities are discussed. The results showed that organic agriculture is underdeveloped in the Ucayali region and is lacking of market. The institution if organic agriculture is not yet efficient. The informal constraints of the institution are inhomogeneous by the diversity of its inhabitants. The formal constraints are not yet involved. The social capital, which is the precondition of economic and social development, as well for organic agriculture development, was on different level, mostly low. Disparity of informal constraints, absence of formal constraints and low social capital, first of all the low trust among the inhabitants of the communities, are the main reason of organic agriculture stagnation in the region. Implementation of certification process as the formal constraint of the institution, which allows entering in the biomarkets, establishment of the product unit to reduce the transaction costs and cooperation with the farmers with high social capital could allow the development of organic agriculture in the region.

Keywords: Formal and informal constraints, institutional economy, institutional xerox, pucallpa, social capital

Contact Address: Jana Lojkova, Czech University of Agriculture, Institue of Tropics and Subtropics, Czech Republic, e-mail:

Conserving the Indigenous-organic Rice Farming System of Coastal Kerala, India: Does the Market Provide Superior Solutions Than the Standards?

VIJESH VIJAYA KRISHNA[1], S. SURYAPRAKASH[2], SETHULEKSHMI KUMBALATH RAJAGOPAL[3]

[1]*University of Hohenheim, International Agricultural Trade and Food Security, Germany*

[2]*University of Agricultural Sciences, Department of Agricultural Economics, India*

[3]*Kerala University, Thiruvananthapuram, University Library Research Centre, India*

This paper examines the conservation alternatives for the indigenous rice-prawn farming system, known as Pokkali farming of Coastal Kerala (India), under the Command and Control (C&C) and market creation frameworks. The system exists as a world-acclaimed farming model complementing the natural system, utilising indigenous knowledge and ensuring efficient utilisation of local resources. The proximity to sea and subsequent periodical seawater inundation ensure the uniqueness of the rice varieties cultivated, and contribute to the high degree of specialisation in the cultural practices followed in the region. The less remunerative rice cultivation compliments a highly profitable prawn culture, making it a unique agro-ecological continuum. The farming system is traditionally organic, as farmers desist from use of agrochemicals in rice farming which hampers the productivity of the succeeding crop, i.e., the prawn culture. But lately, the unsustainable monoculture of prawn has caught up, which though provides higher net return over rice-prawn culture in short run, is found to be unsustainable both from ecological and social contexts. The cost-benefit and production function analyses were taken up to substantiate that short-run economic incentives form the primary reason for this shift. Despite the state government's direct intervention that has made the monoculture illegal, more area is being gradually brought under fallow-prawn and prawn-prawn systems, owing largely to the multitude of constraints associated with the labour-intensive rice cultivation. The market mechanism, involving a price premium for the branded Pokkali rice, can be seen as an efficient alternative for the *in situ* conservation of the indigenous varieties and cultivation practices. Though Pokkali rice is distinguishable in taste, quality and utility from the conventional rice, a positive willingness to pay is ensured for this indigenous-organic rice, especially in case of the urban consumers. Considering the merit good status of organic products, state intervention, especially in the form of subsidies was found to be highly popular among the farmer and consumer groups.

Keywords: Command and control, indigenous farming system, Kerala, Market creation, Organic rice, Pokkali lands

Contact Address: Vijesh Vijaya Krishna, University of Hohenheim, International Agricultural Trade and Food Security, 70593 Stuttgart, Germany, e-mail: vkrishna@uni-hohenheim.de

The Effect of Conventional and Organic Farming on Cabbage (*Brassica oleracea* Var. *capitata* L.) Yield - a Case Study in Lembang, Indonesia

YEYEP DINTAN[1], RONALD F. KÜHNE[2], ANAS DINURROHMAN SUSILA[3], ELKE PAWELZIK[4]

[1]*Ministery of Agriculture, Extension and Training Centre Lembang, Indonesia*

[2]*Georg-August-Universität Göttingen, Institute for Plant and Animal Production in the Tropics, Germany*

[3]*Agricultural University Bogor, Horticulture, Indonesia*

[4]*Georg-August-University Göttingen, Institute of Agricultural Chemistry, Germany*

Cabbage is the 3rd most important vegetable grown in Indonesia. A major production area is located in the highland near Lembang,West Java. High doses of mineral N with frequent chemical pesticide application is the most common farming practice, with high potential risk to environment and consumer safety. Farm yard manure and biopesticides are major elements of organic farming which has been suggested as viable alternative.

A field experiment (randomised complete block) was conducted in 2005 on the station of the Indonesian Vegetables Research Institute, Lembang to test if chicken manure (20 t/ha) and a biopesticide (*Bacillus thuriengensis*) can maintain yield of an early and late cabbage variety (Green Coronet and Gloria Ocena) on an Andosol as compared to standard practices (100 and 200 kg N/ha with weekly applications of Chlorfenafir) and an additional zero control.

Cabbage growth and yield was the lowest in the zero control across both culticars (23 t/ha net weight). Moreover, 40 % of the heads were damaged by cabbage moth (*Plutella xilostella*) and head caterpillar (*Crocydolomia binotalis*) to such an extent that it would not be accpetable for consumers. Biopesticide combined with manure application had a net yield of 40 t/ha, with an average damage level of 17 %. In general, synthetic pesticide application combined with 200 kg N/ha had the highest net yield (57 t/ha) and lowest damage (5 %) across both cultivars. However, explorative analysis for pesticide residue showed contamination levels (0.9 — 11 mg/kg) high above the critical limit (0 mg/kg). Furthermore, high nitrate-N contents in the heads (118 mg/kg) as well as very high residual nitrate-N in the topsoil (425 mg/kg) clearly show that further research and monitoring is necessary to improve consumer safety and reduce pollution risk to the groundwater. Manure application alone could not reduce nitrate levels of plants and soil to an acceptable level. Further research in crop rotation and use of catch crops are suggested to improve N efficiency of manure applications.

Keywords: consumer safety, conventional farming, organic farming, pollution

Contact Address: Ronald F. Kühne, Georg-August-Universität Göttingen, Institute for Plant and Animal Production in the Tropics, Grisebachstraße 6, 37077 Göttingen, Germany, e-mail: rkuehne@gwdg.de

Performance of Bushy Forage Legumes in Dynamic Smallholder Pasture Systems of Northeastern Amazon, Brazil

STEFAN HOHNWALD[1], ELIANA M. ACIOLI DE ABREU[2], JONAS BASTOS DA VEIGA[3], JOSÉ ADÉRITO RODRIGUES FILHO[3], CLEMENS WOLLNY[4]

[1]*Georg-August-University Göttingen, Institute of Animal Breeding and Husbandry in the Tropics and Subtropics, Germany*
[2]*Federal Rural University of the Amazon, Animal Production, Brazil*
[3]*Brazilian Agricultural Research Corporation (EMBRAPA), Brazil*
[4]*International Livestock Research Institute, (ILRI), Ethiopia*

In northeastern Pará, smallholders often use cattle just as a financial instrument on their diversified farms: e.g. they buy cattle if cash flows in from crop harvest, and sell them if cash is needed for investment. Thus, animal production systems become dynamic, and inappropriate stocking rates lead to early pasture degradation. Further on, many promising woody tropical forage legume species show development problems if directly grazed on small-scale grass-legume pastures because management, for instance, has also to be adapted to grass availability. Thus, the legumes' need for sufficient recuperation time is often neglected. However, experience shows hat even overgrazed bushes easily recuperate if enough recuperation time is given. Thus, we hypothesise that in the flexible smallholder pasture system, with both long-term overgrazing and recuperation time, the performance of woody forage legumes is higher than on an intensively used pasture. An on-farm experiment is conducted in the municipality of Igarapé-Açu (47º36´W/1º08´S) to test this hypothesis: two dynamic pasture systems with extraordinary high stocking rates (2 and 3 AU/ha, respectively) and long restoration times (38 and 83 days, respectively) are tested against an intensively used grass-legume pasture. Stocking rates are increased until 3 AU/ha after crop harvest and dropped to 0.5 AU/ha during smallholders´ investment times. The investment and harvesting times of the following crops will be considered: maize, cassava, beans, passion fruit, pepper, and fruit trees. Each treatment are planted with alternating lines of totally 300 *Cratylia argentea* and *Flemingia macrophylla* bushes, each, on 0.5 ha *Brachiaria brizantha* pastures. The experiment is replicated three times. Three crossbred steers, with an average liveweight of 185 kg graze the plots according to different smallholding scenarios. Legume establishment and development are evaluated by measuring bush heights, relative growing performance, diameters, biomass, consumption ratio, and nodule production during the three years of experimental time. The study will show if bushy forage legumes contribute more on hardly managed smallholder or on well-managed pastures.

Keywords: Animal production, *Cratylia*, *Flemingia*, N-fixation, pasture management, smallholding

Contact Address: Stefan Hohnwald, Georg-August-University Göttingen, Institute of Animal Breeding and Husbandry in the Tropics and Subtropics, Kellnerweg 6, 37077 Göttingen, Germany, e-mail: shohnwa@gwdg.de

Study of Secondary Vegetation Treated as Bokashi on the Intercropped Maize and Soybean of Smallholding Farmers Land in Southeast Sulawesi, Indonesia

LA KARIMUNA

University of Haluoleo Kendari, Department of Agronomy, Indonesia

Slash-and-burn agricultural system is being practised by more than 80 % of the population in Southeast Sulawesi province. This system could no longer be maintained due to low yield of crops observed. Moreover, the number of soil limiting factors, such as low soil macronutrient contents, low cation exchange capacities, shallow top soil layers, and high soil acidities, were profoundly discovered. Therefore, the farmers are still under poverty condition. High input technology using inorganic fertiliser to increase agriculture production has terribly experienced since negative impacts on the environment widely occurred. One of the abundant natural resources is the presence of secondary vegetation in land use agricultural system after fallowing. The main objective of this paper was to overview the potential biomass derived from secondary vegetation as an organic fertiliser on the growth and yield of various crops. The species composition, biomass and nutrient stocks of secondary vegetation as well as the potential use as source of the organic fertiliser had been reported. The species diversity of vegetation in the early stages of development was principally controlled by *Chromolaena odorata* L., *Imperata cylindrica* L. Beauv and *Colopogonium mucunoides* L, and the nutrient stocks preserved, i.e. N, P, and K contents, were determined. The application of EM4 might help organic biomass to be rapidly decomposed in order to release nutrient into the soil. The response of intercropped maize and soybean treated as bokashi originated from combined secondary vegetation such as *C. odorata*, *I. cylindrica* and *C. mucunoides*, consisting of three levels: 0 t ha^{-1}, 5 t ha^{-1} and 10 t ha^{-1}, was also described. The results revealed that the treatment of 10 t ha^{-1} was better than other treatments, with the total maize yield of 4.5 t ha^{-1}. Similar results on the application of *C. odorata* itself showed high yield of intercropped maize and soybean amounted to 5.2 t ha^{-1}. The application of organic fertiliser, derived from *C. odorata*, *C. mucunoides*, and *Albizzia lebbeck*, might increase doubled or even tripled the yield of maize, peanut, soybean, and mungbean compared to control, indicating the promising results of the potential organic fertiliser use, replacing slash-and-burn to slash-and-mulch system for the smallholding farmers to improve their income and welfare.

Keywords: *Chromolaena odorata*, intercropping4, organic fertiliser, slash and burn

Contact Address: La Karimuna, University of Haluoleo Kendari, Department of Agronomy, Komp. Perum Dosen UNHALU Block M/7 Anduonohu, 93232 Kendari, Indonesia, e-mail: lkarimuna@hotmail.com

Farmers' Perception and Use of Planted *Calliandra calothyrsus* Fallow in Southern Cameroon

STEFAN HAUSER[1], MUSTAPHA NJAYOU[1], LOUIS ZAPFACK[2]

[1]*International Institute of Tropical Agriculture, Humid Forest Eco-regional Center, Cameroon*
[2]*University of Yaounde, Plant Biology,*

The leguminous tree *Calliandra calothyrsus* was introduced to farmers in southern Cameroon for soil fertility and crop yield improvement in shortened fallow phases in 1989. On-farm trials by ICRAF and IITA used the alley cropping concept, and various spatial patterns and tree densities. Initially 2 year old fallow was cropped after slash and burn land preparation. This study reports farmers' perception of the effects of *C. calothyrsus* fallow in four areas and verifies if farmers used the system without researchers' involvement.

After the initial 2 years fallow, 95 % of farmers cropped, after the second and third fallow 41 % and 13 % cropped, respectively. Labor requirements to clear and prepare land after *C. calothyrsus* was perceived as being larger than after natural fallow by 86 % of farmers after the first fallow; and by 24 % and 13 % after the second and third fallow. Perceived and recorded labour requirements were closely correlated. Across all crops, 61 % of farmers perceived yields being higher after *C. calothyrsus* than natural fallow; 17 % did not report any difference. Perceived yield advantages after *C. calothyrsus* increased from 57 % after the first fallow to 77 % after the third fallow. Yield perception varied with location: in the south 45 % of farmers believed *C. calothyrsus* produced higher crop yields, compared with 70 % north of Yaounde. Maize was believed by 78 % of farmers to produce higher yields in *C. calothyrsus*. Groundnut was believed to not respond positively to *C. calothyrsus* with 45 % of farmers reporting higher yields in *C. calothyrsus*. Cassava yields were perceived by 62 % of farmers as higher in *C. calothyrsus*. For sites where yields were measured by researchers, farmers either incorrectly perceived a yield advantage or overestimated the yield advantage of *C. calothyrsus* by a wide margin. The decline in the use of *C. calothyrsus* fallow indicates, that increased labour requirements for clearing and land preparation outweighed perceived and real yield advantages. Consequently, *C. calothyrsus* is virtually only used in the high population density area north of Yaounde. The species can neither be recommended for large areas nor for all crops.

Keywords: Adoption, alley cropping, labour requirements , tree based fallows

Contact Address: Stefan Hauser, International Institute of Tropical Agriculture, Humid Forest Eco-regional Center, Cameroon, e-mail: s.hauser@cgiar.org

Maize Yield Response to *Mucuna pruriens* and *Pueraria phaseoloides* Cover Crop Fallow and Biomass Burning Versus Mulching in Farmer Managed On-farm Experiments

STEFAN HAUSER, BERTRAM BENGONO, OBATE BITOMO
International Institute of Tropical Agriculture, Humid Forest Eco-regional Center, Cameroon

Maize was relay cropped with the cover crops *Mucuna pruriens* or *Pueraria phaseoloides* or in natural fallow for one to seven consecutive years in three sites: Ngoungoumou, an area of low land use intensity (LUI), 100km from the next major market, at Evendissi and Andok, a medium LUI area, 15km from the next mayor market. Biomass was burned or retained as mulch in all fallow types. Fallow type did not affect maize density. Biomass burning increased maize density in the low LUI site but had no effect in the other sites. Maize cob production was neither affected by fallow type nor by biomass management. Across seven crop years, marketable cob production in the low LUI site was 38.5 % higher in *Mucuna* than in natural fallow ($p < 0.06$). In the medium LUI sites, *Mucuna* and *Pueraria* fallow increased marketable cob production by 70 — 132 % ($p < 0.001$). Maize grain yield was closely related to the marketable cob production in all sites. In the low LUI site, cumulative maize grain yield over seven years was 30 % higher in *Mucuna* than in natural fallow ($p < 0.07$). This difference was in one year significant ($p < 0.05$). In the other sites maize grain yield was 65 % higher in *Mucuna* fallow ($p < 0.001$) and 69–94 % higher in *Pueraria* fallow ($p < 0.001$). Burning biomass had a cumulative grain yield advantage of 33 % at the low LUI site ($p < 0.053$), with significant ($p < 0.02$) differences in two out of seven years. Biomass burning had no effect on maize grain yield in the medium LUI sites. Fallow type and biomass management did not interact. Despite the lack of frequent significant advantages of the cover crop fallows in the low LUI site, the system can be recommended because it increases food diversity. In the medium LUI sites farmers were immediately convinced of the benefits of the system and have since moved on to grow high value vegetable crops.

Keywords: Cameroon, maize, *Mucuna pruriens*, *Pueraria phaseoloides*, Ultisol

Contact Address: Stefan Hauser, International Institute of Tropical Agriculture, Humid Forest Eco-regional Center, Cameroon, e-mail: s.hauser@cgiar.org

Nitrogen Fixation and Balance in Burned Versus Mulched *Mucuna pruriens* Var. *utilis* and *Pueraria phaseoloides* Relay Maize Cropping Systems

STEFAN HAUSER

International Institute of Tropical Agriculture, Humid Forest Eco-regional Center, Cameroon

The cover crops *Mucuna pruriens* var. utilis and *Pueraria phaseoloides* are gaining importance in annual sole maize cropping and horticultural systems in the humid forest zone of West and Central Africa. Their contribution to the N balance of a sole maize relay cropping system was estimated. Over four consecutive years (1998 to 2001), amounts of N in 8–9 months old aboveground *M. pruriens*, *P. phaseoloides* and natural fallow biomass and litter were determined. In all years fallow biomass was either burned or retained as mulch and a sole maize crop was grown. Maize aboveground N-accumulation and N-export with grain was determined. The amount of N_2-fixed was estimated with the N difference method. In 1998, 1999, and 2000, nitrogen content in biomass of *M. pruriens* and *P. phaseoloides* fallow was higher than in natural fallow. In 2000 and 2001 fallow biomass in previously burned plots contained less N than when biomass had been retained. There was no fallow-type $\times$ biomass management interaction. Maize N uptake was higher in the biomass burned treatments in 1998, yet thereafter higher in the biomass retained treatments. Fallow type had only in 1999 an effect with highest maize N uptake in the *P. phaseoloides* system, followed by the *M. pruriens* system and the natural regrowth. The estimated amounts of N_2-fixed were higher in the *P. phaseoloides* system; biomass management had no effect. Nitrogen export with maize grain was highest in the *P. phaseoloides* system, followed by the *M. pruriens* system; biomass management had no effect across years. Nitrogen uptake into the aboveground maize biomass and N export with grains was balanced by the amount of N in fallow biomass and litter in all systems where biomass was retained. The amount of N_2-fixed did not balance the amount taken up by the maize. In the *M. pruriens* system the N exported with grains was not balanced by N_2-fixation. Only the *P. phaseoloides* system had a positive balance of N export in grain versus the amount of N_2-fixed.

Keywords: Cameroon, cover crop, maize, *Mucuna pruriens*, N balance, *Pueraria phaseoloides*, symbiotic N fixation, Ultisol

Contact Address: Stefan Hauser, International Institute of Tropical Agriculture, Humid Forest Eco-regional Center, Cameroon, e-mail: s.hauser@cgiar.org

The Use of *Azolla sp.* to Increase N Fertiliser Use Efficiency in Wetland Rice in Dano, Southwestern Burkina Faso

BENEDICTA FOSU[1], PAUL L. G. VLEK[2], GÜNTHER MANSKE[2], KONRAD VIELHAUER[2]

[1] *University of Bonn, (ARTS) Agricultural Science and Resource Management in the Tropics and Subtropics, Germany*

[2] *University of Bonn, Center for Development Research (ZEF), Germany*

The use efficiency of N fertiliser in lowland rice is often low because of its loss from the soil through biochemical processes. Nitrogen recovery by rice can be as low as 10 % and rarely exceeds 60 %. Ammonia (NH_3) volatilisation, usually associated with high soil pH and NH_4^+ concentration, is reportedly an important mechanism for N losses. *Azolla sp.*, a water fern fixing atmospheric nitrogen in symbiosis with *Anabaena azolla*e was used as a physical barrier to prevent the volatilisation of NH_3. The influence of *Azolla* on the floodwater chemistry and its relation to NH_3 volatilisation, its impact on N uptake by rice and its impact on rice yields was evaluated.

In a field experiment at the Dreyer Research station farmer's practice (basal application of NPK 16 16 16 and one top-dress of urea) "U1" was used as opposed to a split urea application "U2". Secondly, the influence of *Azolla* (with and without) was assessed in plots at 0, 40, 80 and 120 kg N ha 1 with respect to floodwater chemistry, NH_3 volatilisation, N uptake, crop growth and grain yield.

Results revealed that full *Azolla* cover on the floodwater surface by the time of urea application prevented rapid increase in floodwater pH in the range of 0.52 to 0.68 with the maximum pH value below 8.0. The absence of *Azolla* resulted in a rise of floodwater pH with a maximum of 8.97 and 8.63 for U2 and U1, respectively. Floodwater temperature was lowered by 1.9–2.0oC by Azolla.

In the presence of *Azolla* total dry matter yield increased by 7.8 % in U2 and 9.8 % in U1 and grain yields increased by 3.9, 6.4 and 3.9 % in U2 and 1.8, 7.0 and 5.6 % in U1 for N rates at 40, 80 and 120 kg ha 1, respectively. The apparent N-recovery of rice was increased between 13.3 and 16.8 % for grain and 39.1 and 42.6 % for straw. Plant height, tiller count and panicle count, in plots with *Azolla* were higher.

It was concluded that the application of *Azolla* could be an efficient fertiliser alternative or supplement in flooded rice cropping system in Dano.

Keywords: Ammonia volatilisation, *Anabaena azollae*, *azolla pinnata*, nitrogen fixation

Contact Address: Konrad Vielhauer, University of Bonn, Center for Development Research (ZEF), Walter-Flex-Straße 3, 53113 Bonn, Germany, e-mail: kvielhau@uni-bonn.de

Interactions Between Coffee (*Coffea arabica* L.) and Intercropped Aromatic Plants under Field Conditions in the Sierra Norte of Puebla, Mexico

ALEX GUSTAVO PACHECO BUSTOS[1], HEINER GOLDBACH[1], JÜRGEN POHLAN[2]
[1]*University of Bonn, Institute of Crop Science and Resource Conservation, Germany*
[2]*El Colegio de la Frontera Sur (ECOSUR), Manejo Integrado de Plagas, Mexico*

In the context of studying allelopathic interactions between coffee (*Coffea arabica* L.) mint (*Mentha piperita* L.), Genovese basil (*Ocimum basilicum* L.), oregano (*Origanum vulgare* L.) and sage (*Salvia officinalis*), we tested the effect of the intercropped species on coffee growth and age of the coffee plantation on the intercropped herbs under two ecological conditions (900 and 500 masl) in Puebla, Mexico from February to December 2005. Caffeine released from decaying seeds and leaves accumulates in a soluble form in the soil. The compound is known to inhibit mitosis, limits the access of nutrients and water to surrounding plants which is one of principal problems in intercropped coffee plantations. The results demonstrate that sage, oregano, spearmint and basil are suitable for growing intercropped with different coffee cropping systems. In this study, we observed growth stimulation on coffee plants due to volatilisation of essential oils of intercropped species. These volatile essential oils can affect the leaf surface of coffee, diminishing the effect of oxidative stress caused by management and pruning. All tested herb species stimulated plagiotropic growth of coffee plants, increasing the length of the branches and the appearance of new leaves. There are indications that these herbs cope with high caffeine levels, stimulate coffee growth by a still unknown mechanism. Intercropping certain aromatic herbs with coffee may provide an extra income for coffee growers outside the harvest period. Intercropping basil, sage, spearmint and oregano in coffee plantations seems to be a promising approach for higher income and increasing yield production in coffee farms. Further research of the biochemical nature of these interactions is promising and needed.

Keywords: Allelopathy, caffeine toxicity, coffee (*Coffea arabica*), intercropping, *Mentha piperita*, *Ocimum basilicum*, *Origanum vulgare*, *Salvia officinalis*

Contact Address: Alex Gustavo Pacheco Bustos, University of Bonn, Institute of Crop Science and Resource Conservation, Endenicher alle 37, 53121 Bonn, Germany, e-mail: alexpacheco30@hotmail.com

Impact of Traditional Farming Practices on Nutrient Balances in Smallholder Farming Systems of Nakuru District, Kenya

RICHARD ONWONGA[1], BERNHARD FREYER[2]

[1]*Ministry of Agriculture, Nairobi, Kenya, Agroforestry and Soil Fertility, Kenya*

[2]*University of Natural Resources and Applied Life Sciences (BOKU), Institute of Organic Farming, Austria*

The smallholder farmers have not been influenced by the "Green Revolution" as they have continued with the practice of non-use of chemical fertilisers, pesticides and genetically modified organisms. These practices are referred to as "Traditional Farming". Animal compost and recycling of crop residues are the principal soil fertility management strategies in the smallholder farming systems (SHFS). However, few studies have investigated the impact of these practices on soil fertility in the SHFS.The impact of traditional farming practices (TFP) on soil fertility was assessed through quantification of nutrient (N, P and K) balances using farm-NUTMON. The study was conducted in Gilgil, Lare and Molo divisions of Nakuru district, from April 2003 to March 2004. A total of 36 farmers, twelve per study site representative of the socio-economic classes participated in the study. The full farm N, P and K balances were positive for Gilgil (55, 40, 25 kg ha^{-1} yr^{-1}), negative for N and P in Molo (-86, -4, 4) and N in Lare (-60, 5, 4). The nutrient N, P and K balances in cropping activities were negative with large variations across land use types and study sites. Highly negative N, P and K balances in cropping activities were realised in Lare (-117, -45, -44), followed by Molo (-66, 2, -21) and Gilgil (-42, $^{-1}$, 0). The pasture and fodder (all sites) and cereals (Lare) land use types had the highest nutrient depletion rates. Crop production is thus unsustainable, under the TFP, with respect to nutrient balances. In view of the central role that manure plays in enhancing soil fertility of the smallholder farms, its proper management and handling is considered critical. Efficient use of organic resources and introduction of other organic farming based technologies (e.g. legumes in short rain season) will tremendously enhance the soil fertility status and subsequently lead to increased crop production. Composting, biomass transfer, improved fallows, agroforestry, and cover crops are such technologies feasible for adoption in the smallholder farms. Further research on the socio-economic impact of these technologies is recommended.

Keywords: Kenya, Nutrient balance, Organic Farming, Traditional farming

Contact Address: Bernhard Freyer, University of Natural Resources and Applied Life Sciences (BOKU), Institute of Organic Farming, Gregor Mendel Straße 33, 1180 Wien, Austria, e-mail: Bernhard.Freyer@boku.ac.at

Soil Biology and Fertility

Impact of Legume Versus Cereal Roots on Chemical and Biological Properties of West African Soils

BEATE FORMOWITZ[1], ANDREAS BUERKERT[1], RAINER GEORG JOERGENSEN[2]

[1]*University of Kassel, Organic Crop Production and Agroecosystems Research in the Tropics and Subtropics, Germany*

[2]*University of Kassel, Department of Soil Biology and Plant Nutrition, Germany*

To investigate whether root residues of legumes and their specific decomposition are responsible for the yield increases on the subsequent cereal in a rotation, 2 g kg^{-1} soil of dry roots of cowpea (*Vigna unguiculata* Walp.; CP), groundnut (*Arachis hypogaea* L.; G), pearl millet (*Pennisetum glaucum* L.; PM), maize (*Zea mays* L.; M) and sorghum (*Sorghum bicolor* Moench; SO) were applied to pre-incubated monoculture soils from Fada (Burkina Faso, F) and Koukombo (Togo, K). Other treatments comprised mineral phosphorus (P) application in an amount equal to the applied P through legume root residues and a control (Con). At 5 sampling times over a period of 189 days (0, 7, 21, 63 and 189 days after incubation) microbial biomass C (Cmic) and N (Nmic) were determined and the soil respiration was measured initially every two days and later weekly. During the first 3 weeks Cmic concentrations were almost 41 % higher in FG and 38 % higher in FCP compared to FCon. In the Koukombo soils 43 % higher Cmic concentrations were measured in KPM than in K*P.* Significantly higher Nmic concentrations were determined in FG (11.6 μg g^{-1}) and FSO (10.5 μg g^{-1}) compared to FCon (6.2 μg g^{-1}). Nmic concentrations measured in KPM (7.0 μg g^{-1}) were significantly higher compared to KP (4.7 μg g^{-1}) and KCon (3.7 μg g^{-1}) and soil respiration was up to 11-fold higher in FG than in FCon, whereas it was up to 16 fold higher in KP compared to KCon. Even if no legume-specific effects on microorganisms were observed in Koukombo soils, the system-specific effects in the Fada soils indicate that influences of legume root residues and their decomposition on the microbial population might contribute to the yield-enhancing effect of legume rotations. A subsequent experiment with analyses of adenylates, microbial P, ergosterol, pH, and POM finalized by September 2006 will allow more insights into soil biological and biochemical factors.

Keywords: Legume-rotation, microbial biomass , root residues, sahel

Contact Address: Beate Formowitz, University of Kassel, Organic Crop Production and Agroecosystems Research in the Tropics and Subtropics, Steinstr. 19, Witzenhausen, Germany, e-mail: formowitz@uni-kassel.de

Assessing the Effect of Management Practices on Soil Microbial Communities in a Vertisol Using Enzyme and ^{15}N-DNA Stable Isotopic Probing Techniques

MINGRELIA ESPAÑA[1,2], BELKYS RODRIGUEZ[2], ELLEN KANDELER[3], GARY BENDING[4], GEORG CADISCH[1]

[1]*University of Hohenheim, Institute of Plant Production and Agroecology in the Tropics and Subtropics, Germany*

[2]*National Institute of Agricultural Research (INIA), Ceniap Maracay, Venezuela,*

[3]*University of Hohenheim, Institute of Soil Science, Germany*

[4]*University of Warwick, Warwick HRI, United Kingdom*

Land use and agricultural management have been shown to cause significant effects on microbial activity, population structure, and on their functions. Recently the approaches for studying soil microbiota have moved from biochemical and microbiological determinations such as enzyme activities, microbial biomass and respiration coefficients towards the investigation of microbial community structures. The effect of different management practices (tillage, residues and cropping systems), on soil enzymes activities and organic carbon content were evaluated in a long-term experiment in a Vertisol conduced at Aragua state in Venezuela since 1997. The most important results from 6 years of evaluation of the biochemical and biological properties showed a contrasting behaviour between tillage systems. Conventional tillage (CT), presented not only higher enzymes activities, but also reduced organic carbon accumulation in the topsoil (0–5 cm). The dehydrogenase activity was higher in CT. The soil enzymatic activities related to N mineralisation such as urease and protease were concentrated in 0–10 cm and were lower in no tillage (NT). The amount of N released from crop residues was higher in CT, indicating a faster decomposition rate of residues due to higher soil biological activity. There was also a lower soil biological activity in the maize-soybean crop rotation system compared to monocrop maize. To identify the active microbial community involved in crop residues decomposition of different quality an incubation experiment is being conduced with ^{15}N-enriched residues using the stable isotopic probing (SIP) technique. We have shown the potential of the ^{15}N-DNA SIP using both pure culture and soil samples when DNA was labelled with $>$ 40 atom%^{15}N enrichment.

Keywords: ^{15}N-SIP, enzymes activity, management practices, microbial community

Contact Address: Mingrelia España, University of Hohenheim, Institute of Plant Production and Agroecology in the Tropics and Subtropics, Garbenstr. 13, 70593 Stuttgart, Germany, e-mail: mespana@uni-hohenheim.de

Mn-oxidation and Reduction Capacity of Rhizosphere Microorganisms as Related to the Severity of Soil Borne Plant Diseases

ZAFRIN AKTER, TSEHEYE TESFAMARIAM, MARKUS WEINMANN, GÜNTER NEUMANN, VOLKER RÖMHELD

University of Hohenheim, Institute of Plant Nutrition, Germany

Crop production is frequently limited by various soil-borne pathogens such as, Streptomyces, *Gaeumannomyces graminis*, Pythium, Sclerotium and Rhizoctonia. Micronutrients play a vital role in determining disease resistance in plants and among them Manganese (Mn) is of outstanding importance. The plant availability of Mn in soils depends on pH, redox potential and microbial activity in the rhizosphere. The activity of Mn-reducing microorganisms in the rhizosphere increases Mn solubility, while Mn can be immobilised by microbial Mn oxidisers Many pathogenic microbes exhibit a Mn-oxidising potential (e.g. *G. graminis*) and plant growth promoting microbes are often Mn-reducers (e.g. *Pseudomonas spp.*). However, little information is available on interactions of microbial activity with the Mn status of plants as related with suppression of soil borne pathogens. A better understanding of rhizosphere processes determining plant availability of Mn, may offer perspectives for alternative disease management strategies reducing environmental risks of pesticide applications. In this study, we tested two complementary microbiological methods to investigate the soil Mn-oxidising and Mn-reducing capacity of rhizosphere microorganisms in relation to the severity of soil-borne plant diseases .“Take-all” disease in wheat caused by the soil-borne fungus *G. graminis* var. tritici.was used as a model system. In a culture-dependent method, microbial populations were assessed, using an agar plating technique with selective media. Bacterial colonies of Mn reducers were identified by their clear halo in agar with finely suspended Mn (IV)-oxide, whereas Mn oxidisers were surrounded by dark deposits of oxidised Mn on agar containing reduced Mn^{2+}. In the second method, substrate-induced Mn reduction potential in soil was determined by incubating soil samples with MnO_2 and yeast extract solution for one week under continuous shaking (aeration). Reduced Mn was determined by Diethylenetriaminepentaacetic acid (DTPA) extractaction. The total number of Mn-reducers (log 6.01 to 7.42 cfu per g soil) in different soils was significantly correlated with DTPA extractable Mn (80 to 140 ppm), shoot Mn concentration (18 to 50 ppm) and the severity of take-all disease in wheat.

Keywords: Disease resistance, Mn-oxidisers and Mn-reducers, rhizosphere, Soil-borne pathogens

Contact Address: Zafrin Akter, University of Hohenheim, Institute of Plant Nutrition, Fruwirth Strasse 20, 70593 Stuttgart, Germany, e-mail: zafrin@uni-hohenheim.de

Arbuscular Mycorrhizal Residues Decline with Prolonged Arable Cropping: a Chronosequence Study on Glomalin-related Soil Protein in Sandy Soils of the South African Highveld

ANNE PREGER[1], MATTHIAS RILLIG[2], ANNIKA JOHNS[2], CHRIS DU PREEZ[3], INGO LOBE[4], WULF AMELUNG[1]

[1]*University of Bonn, Institute of Crop Science and Resource Conservation-Soil Science, Germany*

[2]*The University of Montana, Division of Biological Sciences, USA*

[3]*University of the Free State, Department of Soil, Crop and Climate Sciences, South Africa*

[4]*UFZ Centre for Environmental Research, Department River Ecology, Germany*

In coarse textured soils with little biomass input and low capacity to conserve soil organic matter, residues of arbuscular mycorrhizal fungi (AMF) may play an important role for agroecosystem functioning due to their ability to promote soil aggregation. Our aim was to assess the fate of AMF residues with prolonged arable cropping in subtropical savannah soils following the hypothesis that glomalin-related soil protein (GRSP), especially the MAb32B11-immunoreactive fraction, constitutes material of largely AMF origin. In three agroecosystems on the South African Highveld, surface soils with a history of up to 98 years of cropping after conversion from grassland were sampled. We measured four GRSP fractions: Bradford-reactive soil protein (BRSP) and immunoreactive soil protein (IRSP), and easily extractable fractions of both. The primary grassland sites exhibited generally low contents of soil organic matter (SOM) and low GRSP contents. Prolonged arable land use of former grassland soils reduced the content of GRSP further. The decline could be described well with a single exponential function with rate constants ranging from 0.04 to 0.41 y^{-1}. Depending on the GRSP fraction, steady-state conditions were reached after 11 to 92 years on a level of 39 % to 69 % of the initial contents. We conclude that even though GRSP fractions had the same hypothesised origin, they comprised pools with different stability or replacement rate, with easily extractable IRSP being lost most rapidly. Despite potentially negative management effects on AMF, GRSP contents were not reduced below a certain equilibrium content and coincided with low, but stable crop yields. Ongoing research on secondary grassland sites with a cropping history shows that an at least partly restoration of SOM takes place. The next step will be to assess the extent of GRSP restoration and its effects on SOM and soil structure stabilisation in the secondary grassland soils on the South African Highveld.

Keywords: Arable land use, arbuscular mycorrhizal fungi, biomarker, glomalin, soil organic matter

Contact Address: Anne Preger, University of Bonn, Institute of Crop Science and Resource Conservation-Soil Science, Nussallee 13, 53115 Bonn, Germany, e-mail: ac.preger@uni-bonn.de

Effects of Mycorrhizal Inoculation and Inorganic Nutrients on the Efficiency of Biomass Transfer to Okra by *Tithonia diversifolia* Hedges.

MOJEED LIASU, ABOSEDE OGUNDARE

Ladoke Akintola University of Technology, Department of Pure and Applied Biology, Nigeria

The effect of introduced arbuscular mycorrhizal (A.M) fungus i.e. *Glomus mosesae* on phytoextraction of soil nutrients by *Tithonia diversifolia* hedges and efficiency of biomass transfer to potted okra plant were investigated. The first experiment (Field) was a two way factorial design and the two factors were fertiliser application and mycorrhizal inoculation combined to give four treatments i.e. fertilised and inoculated (F+ M +), unfertilised and inoculated, (F- M+) fertilised and uninoculated (F+ M -) and unfertilised and uninoculated (F-M -). Harvesting was done in two consecutive trials each lasting for three months. Harvested leaf biomass from each treatment was applied as mulch to potted okra plants in a second experiment with un-supplemented soil as control and fertiliser supplemented soil as reference. The highest leaf biomass and nutrient yield were at first from *Tithonia* hedges grown in unfertilised inoculated and later from fertilised inoculated soils while the lowest yield in both cases were from unfertilised uninoculated soils. Soils supplemented with mulch from *Tithonia* supported the growth of okra plants better than those supplemented with fertiliser only while those grown in unsupplemented soils had the poorest growth and fruit yield. Fruits produced by okra grown in mulch supplemented soils were generally more acceptable to the taste panel than those grown in unsupplemented soils. The least accepted were those grown in fertiliser supplemented soils. Thus, nutrient extraction from fertilised and unfertilised soils by *Tithonia* hedges was enhanced by arbuscular mycorrhizal inoculation. Soil supplementation with mulch from *Tithonia* was more efficient than directly applied fertiliser in promoting growth and development of potted okra and table quality of the resulting fruit.

Keywords: Biomass transfer, Glomus mosseae, inorganic fertiliser, Okra, soil supplementation,

Contact Address: Mojeed Liasu, Ladoke Akintola University of Technology, Department of Pure and Applied Biology, 23401 Ogbomoso, Nigeria, e-mail: laideliasu@yahoo.com

Changes in Root Morphology and Organic Acids Extrusion Related to Differential P Acquisition by *Brassica* Cultivars

TARIQ AZIZ, SHAMSA KANWAL, RAHMATULLAH, MUHAMMAD AAMER MAQSOOD

Faisalabad University of Agriculture, Institute of Soil & Environmental Sciences, Pakistan

Wide spread P deficiency around the globe and its low use efficiency in agriculture impels to exploit genetic variation among crop species/varieties to increase P use efficiency. Sixteen *Brassica* cultivars were studied for evaluating genetic differences for P acquisition from sparingly soluble phosphate rock (PR) and soluble mono ammonium phosphate (MAP). Plant biomass production and P content were significantly ($p < 0.01$) different among cultivars. Four cultivars (Rainbow, Peela Raya, CON^{-1} and Dunkeld) were studied to identify traits responsible for such contrasting differences. These cultivars were grown low P soil for 40 d under control conditions. Cultivars supplied with two types of P sources differed significantly for biomass production, total root length, specific root length, P and Ca contents both in shoots and roots, and ash alkalinity. Cultivars, Rainbow and Dunkeld, accumulated higher biomass as well as P contents with either P source. To study differences in organic acids extrusion under P deficiency, these cultivars were grown in nutrient solution and after 40 d organic acids were collected. Cultivars varied significantly for total as well as different organic acids when grown with either deficient or adequate P levels. Longer roots and higher quantities of exuded citric acid, malic acid and butaric acid were measured for Rainbow and Dunkeld. Shoot dry matter production had a significant positive correlation with root dry matter (r=0.85, n=32, $p < 0.01$), root length (r=0.59, n=32, $p < 0.05$) and root P uptake (r=0.95, n=32, $p < 0.01$). Efficient P immobilisation in PR by the two cultivars was associated with their longer roots and more exudation of citric acid.

Keywords: citric acid exudation, phosphorus

Contact Address: Tariq Aziz, , e-mail: tasuaf@gmail.com

Rock-phosphate Alleviates Detrimental Effects of Aluminium in Tomato (*Lycopersicon esculentum* L.) Production on Acid Soils

JOSEPH PATRICK GWEYI-ONYANGO, VOLKER RÖMHELD, GÜNTER NEUMANN
University of Hohenheim, Institute of Plant Nutrition, Germany

Application of rock-phosphates is considered as an economically cheaper alternative for chemically processed P fertilisers on tropical soils, promoting rock phosphate solubilisation but limited information exists on secondary effects of rock-phosphates. In this study we provide evidence for beneficial effects of rock-phosphate (RP) on growth and yield of tomato (*Lycopersicon esculentum* L. var Moneymaker), grown on a field site at Maseno, Kenya (Oxisol, pHH_20 4.2; PCAL 90 mg/kg soil). Treatments comprised NO_3, NH_4^+ and 2:1 NH_4NO_3 (100mg N kg^{-1} soil with NH_4^+ and NH_4NO_3N being supplied together with nitrification inhibitor) in combination of with $Ca(H_2PO_4)_2$; (80mg P Kg^{-1} soil), rock P (Hyperphos: 200mg P kg^{-1} soil) and no P. Rock P treatment was either band or deep- placed. The result revealed a clear increase in yield at 46 days after transplanting (DAT) with RP treatments, particularly after rock-phosphate placement close to the roots. This could not be attributed to differences in P-, Ca-, or Mg-nutritional status. However, Al accumulation in shoots was significantly reduced by rock-phosphate treatments between 29 and 46 DAT as compared to either soluble P treatments or when P was omitted, suggesting an alleviatory effect on Al toxicity. This was confirmed by experiments under controlled conditions with tomato seedlings grown in rhizoboxes with quartz sand irrigated with modified Hogland nutrient solution. Rock P was either homogenously distributed over whole rhizobox, or localised to the upper or lower half of rhizobox. The inhibition of root growth by Al (3.2mM $AlCl_3$ after pH adjustment to 4.5) was ameliorated by RP, which was accompanied by increase in the pH at rhizoplane of the Al-sensitive apical root zones, demonstrating prevention of Al-induced inhibition of root elongation by local or homogenous application of rock-phosphates.

Keywords: Acid soils, Al toxicity alleviation, key words. Rock phosphate, *Lycopersicon esculentum* L, rhizoplane pH and RP placement.

Contact Address: Günter Neumann, University of Hohenheim, Plant Nutrition, Germany, e-mail: gd.neumann@t-online.de

Nitrogen Complementarity in Timber Based Hedgerow Intercropping Systems on an Acid Upland Soil in the Philippines

AGUSTIN MERCADO[1], MEINE VAN NOORDWIJK[2], THOMAS HILGER[1], GEORG CADISCH[1]

[1]*University of Hohenheim, Plant Production and Agroecology in the Tropics and Subtropics, Germany*
[2]*World Agroforestry Centre (ICRAF), Southeast Asian Research Program, Indonesia*

Complementarity in agroforestry systems is when trees take up water and nutrients, which would not be available to the associated annual food crops. Hedgerow systems of *Acacia mangium* (N_2-fixing) and Gmelina arborea (non-N_2-fixing) were studied to determine from which soil profiles these trees take up N in relation to the maize crop, and to assess their N contribution. $(^{15}NH_4)_2SO_4$ (40 atom %) was injected at 20 and 100 cm depth using a ceramic porous cup in order to assess ^{15}N uptake by trees and crop. This study was conducted at Claveria, Philippines (8°°30 N 124°°53' E) on a fine mixed isohyperthermic, Ultic Haplorthox soil with 3500 mm rainfall per year distributed throughout the year. Nitrogen recycled in tree systems wase substantially higher than in the conventional maize monocrop system through pruning of lateral branches and N uptake from safety-net zone. *A. mangium* system provided two times more N recycling through prunings compared to the equally fast growing G. arborea. *A. mangium* derived 42 % of its N from atmospheric N_2 fixation and 52 % from safety-net zone (>100 cm depth). This counterbalanced the mineral N uptake by *A. mangium* from the upper soil depths, leading to higher maize yields and a positive system N balance. *A. mangium* had more fine roots even at lower depths, which provided good opportunities for safety-net and nutrient pumping functions compared to G. arborea. The maize in *A. mangium* system benefited with 28 % of its N uptake through transfer of fixed N_2, e.g., through the application of lateral branches prunings and root turnover, as indicated by the ^{15}N natural abundance method. *A. mangium* was less competitive with maize than G. arborea, and was thus more appropriate as a hedgerow species. Timber hedgerow system is a better farming option than the conventional maize system due to the N uptake by trees from lower soil depths regardless of species being used.

Keywords: Hedgerow intercropping, N complementarity, timber trees

Contact Address: Georg Cadisch, University of Hohenheim, Plant Production and Agroecology in the Tropics and Subtropics, Garbenstraße 13, 70593 Stuttgart, Germany, e-mail: cadisch@uni-hohenheim.de

Litterfall Deposition in Subtropical Woodlands, Northeastern Mexico

HUMBERTO GONZÁLEZ RODRÍGUEZ[1], ISRAEL CANTÚ SILVA[1], MARCO V. GÓMEZ MEZA[2], ROQUE G. RAMÍREZ LOZANO[3]

[1]*University of Nuevo Leon, Faculty of Forest Sciences, Mexico*

[2]*University of Nuevo León, Faculty of Economics, Mexico*

[3]*University of Nuevo Leon, Faculty of Biology, Mexico*

Litterfall is one of the basic and fundamental processes of nutrient cycling in forest ecosystems. This process represents one of the major pathways for the return of organic matter and nutrients from the vegetation to the soil (Montagnini and Jordan 2002, Reyes-Reyes et al. 2003) and therefore contributes to soil formation, structure and fertility. In northeastern Mexico, the main type of vegetation, known as the Tamaulipan thornscrub, is composed of diverse, dense and spiny shrubs and trees which are distinguished by a wide range of taxonomic groups exhibiting differences in growth, leaf life spans, growth dynamics, and phenological development. In this regard, as an approach to understand the seasonal pattern of litterfall dynamics in the subtropical thornscrub woodlands, northeastern Mexico, litter deposition and their respective components were quantified at three sites (Ramones, China and Linares counties, in Nuevo Leon state of Mexico). Results have showed that litter deposition for a year study (November 2004 to October 2005) at the three sites ranged from 4,619 to 7,171 $kgha^{-1}$. In terms of literfall constituents, leaves represented the main component with a deposition that ranged from 3,100 to 4,715 $kgha^{-1}$. Twigs deposition ranged from 545 to 1,546 $kgha^{-1}$, and reproductive structures (flowers, fruits and seeds) deposition varied from 382 to 545 $kgha^{-1}$. The contribution of other litterfall components such as bark and insect faces ranged between 270 and 820 $kg4ha^{-1}$. Spatial and temporal litterfall deposition rates among sites are related to phenological events, community plant structure and environmental variables such as extreme temperatures.

Keywords: Litter components, Litter production, litterfall, Subtropical woodlands, Thornscrub

Contact Address: Humberto González Rodríguez, University of Nuevo Leon, Faculty of Forest Sciences, Apartado Postal 41, 67700 Linares, Mexico, e-mail: humberto@fcf.uanl.mx

Litter Fall Production in West-African Forests and Plantations

ZHIXIN DENG, MARC J. J. JANSSENS
University of Bonn, Institute of Crop Science and Resource Conservation, Germany

Tree litter fall is the major above-ground input of carbon (and nutrients) into the forest and plantation floor. Such litter layer protects the underlying humus and mineral soil against drought and represents a considerable buffer improving the ecosystem capacity. However, on regional scale, litter fall data are scarcely available on sufficient stands, which is to be collected and analyzed, when estimating carbon budgets and accounting green house gas needed to address international agreements. In many local studies, the annual litter fall flux has been found to correlate with site, stand, climate characteristics. This opens the possibility of making models to predict tree litter fall on reginal scale both in forests and plantations where it is not measured directly.

To develop such models, litter fall was collected and analysed in locally representative secondary forests and different tree plantations (mango, orange, oil palm, cashew, teak) in Benin, West Africa, with a monthly interval and from North to South Benin (10°N_2°E‰6°N_2°E) covering the unimodal and bimodal Guinean Coast climate regime. Then data from a number of West African projects, in which litter fall and other stand parameters had been determined, were compiled. This combined data set was used to identify the most significant litter fall factors among readily available variables of site (longitude, latitude, elevation, soil type, carbon, nitrogen, phosphor, potassium, cation exchange capacity and PH value…), stand (diameter at breast height, basal area, tree height, number of stems, crown diameter, specific leaf area index, eco-volume…) and climate (annual and monthly precipitation amount, number of rainy days, temperature…). Accordingly, prediction models of litter fall were developed.

Keywords: Benin, carbon budget, forest, litter fall production, modelling, plantation, West Africa

Contact Address: Zhixin Deng, University of Bonn, Institute of Crop Science and Resource Conservation, Auf dem Hügel 6, D-53112 Bonn, Germany, e-mail: deng@uni-bonn.de

Comparing Static and Dynamic Soil Tests for the Assessment of Nutrient Availability in a Low-fertile Lowland Rice Soil in the Red River Delta, Vietnam

FRANK MUSSGNUG[1], MATHIAS BECKER[1], TRAN THUC SON[2], ROLAND BURESH[3], PAUL L. G. VLEK[4]

[1]*University of Bonn, Institue of Crop Science and Resuorce Conservation-Plant Nutrition, Germany*

[2]*National Institute for Soils and Fertilizers, Viet Nam*

[3]*International Rice Research Institute (IRRI), Crop, Soils and Water Sciences Division, Philippines*

[4]*University of Bonn, Center for Development Research (ZEF), Germany*

Little is known about suitable soil analyses methods for intensively cropped lowland rice soils of low fertility status. Therefore, we evaluated the phytoavailability soil test (PST) in comparison to standard laboratory methods (resin bags, chemical extractions) in different treatments of a long-term cropping system experiment on a degraded Acrisol. The trial evaluated three cropping systems (rice—soybean—rice, soybean—rice—maize, and rice—rice—maize) and seven combinations of N, P and K and FYM. Using the PST, the resin absorption quantities (RAQ) determined after 14 days of *in situ* installation of resin capsules indicated nutrient supply capacities for rice that were high for P, in the medium range for K and Fe, but low to very low for Ca, Mg, and Mn. Mixed ion-exchange resin bags extracted 12—26 %, 17—22 %, and 9—18 % of the exchangeable K, Ca and Mg soil contents, respectively, indicating a relatively high initial nutrient release from the soil. Resin capsules predicted the total P and K uptake of lowland rice better than standard soil tests. The correlation was similar for log(RAQ P) (r=0.98) and Olsen-P (r=0.95), while log(RAQ K) predicted 83 % ($p < 0.01$) and exchangeable K only 62 % ($p < 0.05$) of the variation in total plant K. It may be concluded that ion exchange resins provide better estimates of soil nutrient availability than routine soil tests and may be used to guide a site- and system-specific nutrient management approach. In addition, the PST allows the determination of all essential nutrient elements without the need of multiple soil extractions and does not require collecting, drying, grinding and sieving of soil samples.

Keywords: Acrisol, ammonium-acetate extraction, phytoavailability soil test, plant uptake, resin bags

Contact Address: Frank Mussgnug, University of Bonn, Institue of Crop Science and Resuorce Conservation-Plant Nutrition, Karlrobert-Kreiten-Straße 13, 53115 Bonn, Germany, e-mail: f.mussgnug@uni-bonn.de

Pesticide Fate in the Tropical Environment of Brazil: Implications for Sustainable Agriculture and Resource Conservation in the Cerrado Area

VOLKER LAABS[1], ANNE WEHRHAN[2], ALICIO PINTO[3], ELIANA DORES[3], WOLFGANG ZECH[4], WULF AMELUNG[1]

[1]*University of Bonn, Institute of Crop Science and Resource Conservation - Soil Science, Germany*

[2]*Research Center Jülich, Institute of the Agrosphere (ICG IV), Germany*

[3]*Federal University of Mato Grosso, Department of Chemistry, Brazil*

[4]*University of Bayreuth, Institute of Soil Science, Germany*

Within the last 30 years a pesticide-intensive agriculture has been established in the highland regions of Mato Grosso state (Brazil). In a pilot project we investigated the on-site fate of pesticides under tropical field conditions in the Cerrado highlands, the dispersion of pesticides in the northeastern Pantanal catchment, and the persistence of pesticides in the aquatic environment of the Pantanal outskirts.

Field experiments with two representative tropical soils showed that the dissipation of 10 selected insecticides and herbicides in topsoil was rapid (DT50: 0.6 to 20 d). Nevertheless, polar pesticides progressively leached in sandy soils, whereas in clayey soils leaching below the plow layer was mainly caused by preferential flow. The experimental evidence suggests that for alachlor, atrazine, metolachlor, simazine, and trifluralin a non-point pollution of ground water resources in tropical Brazil cannot be ruled out. During a monitoring study, the off-site distribution of 29 pesticides and 3 metabolites was assessed in the north-eastern Pantanal basin. At least one pesticide was detected in 68 % of analysed surface water samples, 62 % of sediment samples, and 87 % of rainwater samples. Surface and rain water samples were most frequently contaminated by alachlor, endosulfan compounds, metolachlor, monocrotofos, profenofos, and trifluralin. While in surface water samples only low concentrations of <0.1 μg L^{-1} were detected, rainwater was polluted with substantial amounts of pesticides in the highlands (maximum concentrations of 0.3 to 2.3 μg L^{-1}) and with 5 to 10 fold lower mean concentrations of pesticides at remote lowland sites. Pesticide fate in the aquatic environment was assessed using semi-field microcosms. Atrazine, endosulfan b, simazine, metolachlor, and alachlor were identified as quite persistent pesticides in water and water/sediment microcosms (DT50 ^{3}44 d). The presence of sediment in microcosms led to increased persistence of non-polar pesticides, while for polar pesticides a decreased persistence was observed.

We deduct that the fast field-dissipation of pesticides in tropical soils of Brazil is in part attributable to increased volatilisation losses of pesticides. The resulting high dispersion tendency of pesticides in the atmosphere may then negatively influence off-site aquatic ecosystems, where pesticides are more persistent than expected under tropical climate.

Keywords: Dissipation, microcosm, monitoring, pesticide, sediment, soil, water

Contact Address: Volker Laabs, University of Bonn, Institute of Crop Science and Resource Conservation - Soil Science, Nussallee 13, 53115 Bonn, Germany, e-mail: volker.laabs@uni-bonn.de

Greenhouse Gas Emissions from Irrigated Agriculture in Khorezm Region (Uzbekistan)

CLEMENS SCHEER[1], REINER WASSMANN[2], JOHN LAMERS[3]

[1]*Center for Development Research, Bonn, Department of Ecology and Natural Resource Management, Germany*
[2]*Karlsruhe Research Center, Institute for Meteorology and Climate Research, Germany*
[3]*Center for Development Research (ZEF), University of Bonn, Germany*

Agricultural systems in the Khorezm region (Uzbekistan, Central Asia) are characterised by monocultures under irrigation in combination with intensive fertilisation. Irrigation and fertilisation of arid systems not only stimulates plant growth, but also a variety of microbial processes enhancing the turn-over of soil carbon and nitrogen (N) leading to elevated emissions of greenhouse gases (GHG) such as N_2O and CH_4. In 2005, GHG emissions were measured from experimental fields at 6 research sites, encompassing 5 different land use types. Emission rates from irrigated agricultural fields were high and represent a significant source of GHG due to N_2O emissions from cotton and winter wheat as well as CH_4 emissions from flooded rice fields. Even an unfertilised plantation of poplar trees showed surprisingly high N_2O fluxes. In contrast, N_2O emissions were very low in spots with native vegetation, i.e. the 'Baday Tugai' riparian forest along the Amu Darya River.

The observed temporal patterns of N_2O emissions were similar for cotton and winter wheat fields. Periods of very high N_2O emissions were triggered by fertiliser application in combination with irrigation. These "emission peaks" accounted for 80 % of the total N_2O emissions over one cotton season. Cumulative N_2O emissions during the cropping season varied between 2.5 kg N_2O-Nha^{-1} - 5.6 kg N_2O-Nha^{-1}, which corresponds to 3.8 % of the total fertiliser applied.

The common management practice of concomitant fertilisation/irrigation in combination with the high soil temperatures during the season leads to an elevated soil microbial activity. Subsequently, the farming systems in Khorezm experience high losses of N via denitrification. This implies low N use efficiency of the fertiliser applied and large emissions of N_2O-gas. Modifications in the amount and timing and modalities of the fertiliser application in combination with improved irrigation techniques may improve the agronomic performance and reduce the environmental impacts.

Keywords: Emission, fertilisation, greenhouse gas, irrigation, N_2O

Contact Address: Clemens Scheer, Center for Development Research, Bonn, Department of Ecology and Natural Resource Management, Kreuzeckbahnstr. 19, D-82467 Garmisch-partenkirchen, Germany, e-mail: clemensscheer@hotmail.com

Productivity and residual benefits of grain legumes to sorghum under semi arid conditions in south-western Zimbabwe

BONGANI NCUBE, KEN GILLER, MARK T. VAN WIJK

Wageningen University, Plant Production Systems, Department of Plant Sciences, Netherlands

The study was conducted for three seasons (2002/03, 2003/04 and 2004/05) in semi-arid southwestern Zimbabwe. The objective was to assess yield and residual benefits to sorghum (*Sorghum bicolor* (L.) Moench) grown after cowpea (*Vigna unguiculata*), Bambara groundnut (*Vigna subterranea*), groundnut (*Arachis hypogaea*) and pigeonpea (*Cajanus cajan*). Two varieties of each legume and a sorghum control were planted in a randomised complete block design, replicated three times. Soil moisture was measured weekly using a neutron probe (Wallingford type). Sorghum was planted after each legume phase, and moisture was also measured. Rainfall variability affected the grain yield of both the legumes and rotation sorghum. In 2002/03 (314 mm) cowpeas produced the largest grain yield (1.1 and 1.6 t ha^{-1}, $p < 0.05$) at 12.5 % moisture content. In a wetter 2003/04 season (650 mm) groundnut varieties had the highest grain yield (0.9 and 1.2 t ha^{-1}, $p < 0.05$). In 2004/05 (301 mm) most legume yields were less than 0.5 t ha^{-1} except pigeonpea ICPL 87091, which produced 0.7 t ha^{-1} ($p < 0.05$). Nitrogen fixed was 15–50 % (2002/03), 16–61 % (2003/04) and 29–83 % (2004/05). Water use by the legumes was related to the legume type and growth duration. Sorghum grain yield in 2003/04 reached 2.2 t ha^{-1} ($p < 0.05$), almost three times the national average. In 2004/05, the sorghum yields were also high (1 — 1.8 t ha^{-1}), but not significant ($p = 0.057$) when the previous legumes were compared. The incorporation of residues had no significant effect on sorghum yield in both seasons. The results showed that there is potential for increasing grain legume cultivation in semi-arid environments. Modelling these results will provide more information on the longer term productivity and sustainability of the rotations.

Keywords: Bambara groundnut, cowpea, granitic sands, groundnut, pigeonpea, soil water

Contact Address: Bongani Ncube, Wageningen University, Plant Production Systems, Department of Plant Sciences, Haarweg 333, 6709 RZ Wageningen, Netherlands, e-mail: bongani.ncube@wur.nl

Biotic Stresses: Fungi and Bacteria

Characterisation of Aflatoxin-producing and Non-producing Strains of *Aspergillus* Section Flavi in Nigeria

MATTHIAS DONNER[1], JOSEPH ATEHNKENG[2], RANAJIT BANDYOPADHYAY[2], SEBASTIAN KIEWNICK[1], RICHARD A. SIKORA[1], PETER COTTY[3]

[1]*University of Bonn, Institute of Crop Science and Resource Conservation-Plant Pathology, Germany*

[2]*International Institute of Tropical Agriculture (IITA), Plant Health Management Program, Nigeria*

[3]*USDA - ARS / University of Arizona, Department of Plant Sciences, USA*

Aflatoxins are toxic metabolites produced by fungi of the genus *Aspergillus*. *Aspergillus flavus* is the most common toxin producing species, but different strains produce different amounts of aflatoxin and some produce none. In West Africa these fungi cause aflatoxin contamination in maize both during crop development and in storage. In a joint project with the International Institute for Tropical Agriculture, the potential of atoxigenic *Aspergillus flavus* strains as biological control agents was assessed for the reduction of aflatoxin contamination of maize in Nigeria. Over 1000 fungal isolates belonging to Aspergillus Section Flavi were collected by dilution plating on modified Rose Bengal agar. The isolates originated from 56 soil samples that were collected from Nigerian maize fields located in five agroecological zones. These isolates were screened for their aflatoxin producing ability in liquid fermentation. Of over 600 isolates screened, 48 % produced detectable quantities of aflatoxin. The aflatoxin B1 production of *A. flavus* isolates varied from 33 ppb up to 19,000 ppb. From each soil sample the producing habit of sclerotia and spores was investigated for high aflatoxin producers and atoxigenic isolates. Isolates that produced high levels of toxin in liquid fermentation produced proportionally less spores and had a higher sclerotia mass on Czapeks agar (31C, 25days), while isolates with high spore mass and less sclerotia mass produced less aflatoxin. The current research involves molecular genetic characterisation of the isolates. Portions of the aflatoxin biosynthetic pathway genes, aflR, as well as genes from the *Aspergillus flavus* genome (taka amylase and pecA) were amplified by PCR and sequenced. Phylogenetic trees were constructed from the sequence data to assess relationships among the toxigenic and atoxigenic isolates. The study demonstrates the differences between aflatoxin producing and atoxigenic *Aspergillus* Section Flavi isolates.

Keywords: Aflatoxin, *Aspergillus flavus*, atoxigenic, toxigenic

Contact Address: Matthias Donner, University of Bonn, Institute of Crop Science and Resource Conservation-Plant Pathology, Nussallee 9, 53115 Bonn, Germany, e-mail: matthiasdonner@web.de

Coffee Leaf Rust (*Hemileia vastatrix*) in the Wild Coffee Population (*Coffea arabica*) of Ethiopia

HOLGER HINDORF[1], ANJA RITSCHEL[2]

[1]*University of Bonn, Institute for Plant Diseases, Germany*

[2]*University of Tübingen, Special Botany/Mycology, Germany*

Coffee (*Coffea arabica*) as a qualified beverage with a great demand in many countries and coffee leaf rust (*Hemileia vastatrix*) as a quarantine pathogen causing high losses have attracted world-wide high attention. Ethiopia as the source of origin for perhaps both, the host and pathogen, plays an important role in science either for breeders or pathologists. Coffee leaf rust occurs in Ethiopia in nearly all areas and under all growing systems like wild, forest, garden and plantation coffee not following a certain altitude preference as in Kenya. Disease assessments could be carried out during 2003 and 2006 in the four different rainforest areas Harenna (Bale Mountains), Bonga, Berhane-Kontir and Yayu of Ethiopia. The disease occurred in all forest sites with varying intensities during the season. After collecting uredinospores in the field morphological characteristics were studied and all samples could be identified as *H. vastatrix* (Ritschel 2005). Finally race specification could be carried out with the necessary differentials in the Center of Coffee Leaf Rust (CIFC) at Oeiras/Portugal. The proof of races II (v5), III (v1,5) and X (v1,4,5) was stated by Varzea (pers. comm.) for wild coffee in the rainforests at Bonga and Berhane-Kontir.

But so far the disease did not influence the production seriously. Several reasons could be responsible for that situation: First of all, since fungicides were never used, the hyperparasite *Verticillium hemileiae* occurs quite frequently and is able to reduce the inoculum under a certain threshold. Secondly the race spectrum might exist of less aggressive races. Race specification will be investigated during a second phase of the project CoCE supported by BMBF and co-ordinated by the Center for Development Research (ZEF), Bonn University.

For further genetical, morphological and phytopathological investigations on the host and pathogen the last ecosystems of rainforest/wild coffee in Ethiopia urgently need to be protected. With international help there exists a strong effort to develop an agrosystem which preserves the natural rainforest including the wild coffee, but allows people to share the benefits of products in that habitat like coffee, spices and fruits.

Keywords: Coffee, Ethiopia, *Hemileia vastatrix*, leaf rust

Contact Address: Holger Hindorf, University of Bonn, Institute for Plant Diseases, Nussallee 9, 53115 Bonn, Germany, e-mail: h.hindorf@uni-bonn.de

Occurrence of *Fusarium* Head Blight—causing Pathogens and Mycotoxins in Kenyan Wheat

JAMES W. MUTHOMI[1], HOLGER HINDORF[2], J.K. NDUNG'U[3], J.K. GATHUMBI[3]

[1]*University of Nairobi, Department of Plant Science and Crop Protection, Kenya*

[2]*University of Bonn, Institute for Plant Diseases, Germany*

[3]*University of Nairobi, College of Agriculture and Veterinary Sciences, Kenya*

Fusarium head blight is a devastating disease of wheat and other small-grain cereals, causing grain yield reduction, reduced quality and mycotoxin contamination. This study was conducted in two districts of Kenya to determine the incidence of *Fusarium* species and mycotoxin contamination in freshly harvested wheat. A survey was carried out during the 2004 growing season in different agro-climatic zones to determine the presence of *Fusarium* head blight and weather conditions during the critical stages of wheat growth. Fungal contamination was determined by isolation on agar media while mycotoxin analysis was by direct competitive ELISA. *Fusarium* head blight was reported by 81 % of the farmers and wet conditions were prevalent during anthesis. The wheat grain samples were highly contaminated with fungi, especially *Epicoccum*, *Alternaria* and *Fusarium* species. The mean *Fusarium* infection rate varied from 13 to 18 %, with the major head blight — causing species being *F. poae*, *F. graminearum*, *F. equiseti*, and *F. avenaceum*. *Fusarium poae*, *F. chlamydosporum* and *F. oxysporum* were the most prevalent in all the agro-ecological zones while *F. graminearum* was isolated in 6 out of the 9 agro-ecological zones. Most grain samples were contaminated with mycotoxins deoxynivalenol, T^{-2} toxin, zearalenone and aflatoxin B1. The most prevalent mycotoxin was T^{-2} (86 % of the samples) followed by deoxynivalenol (59 %), zearalenone (53 %), and aflatoxin B1 (52 %). The maximum mycotoxin concentration was 302 $^{mg}/_{kg}$, 95.8 $^{mg}/_{kg}$, 65.7 $^{mg}/_{kg}$ and 6.9 $^{mg}/_{kg}$ for deoxynivalenol, zearalenone, T^{-2} toxin and aflatoxin B1, respectively. The incidence and levels of the mycotoxins varied depending on the agro-ecological zone. Samples with high proportion of total *Fusarium* infection contained higher deoxynivalenol and T^{-2} toxin levels. Co-occurrence of deoxynivalenol, T^{-2} toxin and zearalenone was fund in up to 35 % of the samples. The results suggested the presence of Fusarium head blight in Kenya and associated mycotoxin contamination, though at low but significant levels. The presence of the different mycotoxins, though at low levels, could pose chronic adverse health effects to human and livestock fed on the contaminated wheat products.

Keywords: head blight, mycotoxins, wheat

Contact Address: James W. Muthomi, University of Nairobi, Department of Plant Science and Crop Protection, P. O. Box 30197, Nairobi, Kenya, Nairobi, Kenya, e-mail: james_wanjohi@yahoo.com

Molecular Analysis of *Citrus tristeza* Virus (CTV) and Citrus-viroids from the Sudan

SUSANNE VON BARGEN, CARMEN BÜTTNER
Humboldt-University Berlin, Institute for Horticultural Sciences, Germany

In the Sudan the mostly grown Citrus species are grapefruit (*Citrus paradisi*, Macfad.) cv. 'Foster pink´ and ´march seedless´, small fruited acid lime (*C. aurantifolia*, Swingle) cv. ´Baladi´ (local), sweet orange (*C. sinensis*, Osbeck), mandarins (*C. reticulata*, Blanco) and lemons (*C. limon*, L.). These are grafted predominantly onto sour orange (*C. aurantium* L.) and also on 'Baladi' lime, which are suitable rootstocks for the arid climate and the high salinity of irrigated soils in the north-eastern region of the Sudan, where Citriculture is most abundant. Certain viroids as well as *Citrus tristeza* virus (CTV) are long suspected to be responsible for many different graft transmissible diseases of Citrus in the arid and semi arid region of the Sudan creating shortage in food supply and also economic problems. Especially *Citrus spp*. grown on sour orange rootstocks yields a highly susceptible combination for CTV. Infected trees are often showing stem pitting and quick decline or die back. On the other hand, Citrus exocortis viroid (CEVd) and Hop stunt viroid (HSTVd) infections of Citrus species are often symptomless on sour orange rootstocks. Exceptions are HSTVd infected mandarins, who are chlorotic, stunted and exhibit typical pegs and gumming of the bark. Serological and molecular techniques were applied and CTV was detected in oranges, mandarins, grapefruit and lime in nine orchards located in Northern State, River Nile and Khartoum. Consecutively it was shown by RT-PCR with viroid specific primers, that some mandarins and orange trees were additionally infected with Citrus isolates of HSVd and CEVd. Full length viroid genomes were cloned and sequences determined. Secondary structure analysis of different viroid-isolates revealed a characteristic genome-organisation of CEVd belonging to Genus Pospiviroid and established Sudanese HSTVd isolates as members of the Genus Hostuviroid. Furthermore the presence of Cachexia inducing isolates of HSTVd in the Sudan was proved by molecular methods.

Keywords: Cachexia, citrus exocortis viroid, Hop stunt viroid, sequencing, viroid secondary structure

Contact Address: Susanne von Bargen, Humboldt-University Berlin, Institute for Horticultural Sciences, Lentzeallee 55/57, 14195 Berlin, Germany, e-mail: susanne.von.bargen@agrar.hu-berlin.de

Diversity of Cassava Mosaic Begomoviruses and the Complex Structure of the Cassava Mosaic Disease in Cameroon

ACHIANGIA PATRICK NJUKENG[1], STEPHAN WINTER[2]

[1]*University of Dschang, Faculty of Science, Cameroon*

[2]*Deutsche Sammlung von Mikroorganismen und Zellkulturen (DSMZ), Plant Virus Division, Germany*

The impact of the Cassava mosaic disease CMD on the reduction of cassava production in Africa in the last two decades has been very dramatic. From the late 1980's a highly severe CMD epidemic emerging in north-central Uganda expanded to affect cassava plantings in much of the Lake Victoria Basin and westwards to the Democratic Republic of the Congo, DRC. The severe decline of the cassava in CMD is implicated with the occurrence of a new recombinant virus, the East African cassava mosaic virus Uganda variant (EACMV-UG), occurring in single and in mixed infection with other begomoviruses in cassava. The greatest challenge posed by the CMD pandemic is its westward expansion to Central and West Africa raising concerns that it may eventually spread to West Africa with Nigeria being the world's largest cassava producing country. Consequently, the virus situation in cassava growing areas in the countries neighbouring DRC requires frequent monitoring, to provide an up-to-date overview on the existing virus populations and on newly invading or evolving virus types. In Cameroon, two begomoviruses, the East African cassava mosaic Cameroon virus, EACMCV, and the African cassava mosaic virus, ACMV, have been reported so far. Single and mixed infections exist with EACMCV infections leading to serious disease phenotypes. Consequently, a virus survey to resolve the complex cassava virus situation Cameroon was conducted. In January/February 2006, cassava with severe CMD symptoms was collected from 21 locations across five agroecological zones of Cameroon. Cassava cuttings were rooted and maintained at the DSMZ virus department to observe developing virus symptoms. Virus infections were studied using a novel PCR approach, the rolling circle amplification, RCA, using the bacteriophage phI 29 DNA polymerase. RCA amplified viral DNA was characterised by restriction fragment length polymorphism, RAPD, resolving a number of polymorphic patterns indicating for further virus variants and/or mixed virus infections. Exact identification of the begomoviruses by sequence analysis further provided information on diversity and distribution of the begomoviruses in Cameroon. Details of the begomovirus populations infecting Cassava in Cameroon will be presented.

Keywords: ACMV, Cameroon, cassava mosaic disease, EACMCV, mixed begomovirus infection, virus population structure

Contact Address: Stephan Winter, Deutsche Sammlung von Mikroorganismen und Zellkulturen (DSMZ), Plant Virus Division, BBA, Messeweg 11/12, Braunschweig, Germany, e-mail: s.winter@bba.de

Geminivirus Induced Gene Silencing for Functional Characterisation of Plant Genes and to Induce Virus Resistance by Rna Interference in Cassava

STEPHAN WINTER[1], M. KOERBLER[1], MERETE ALBRECHTSEN[2]

[1]*Deutsche Sammlung von Mikroorganismen und Zellkulturen (DSMZ), Plant Virus Division, Germany*

[2]*Danish Institute of Agricultural Sciences, Department of Genetics and Biotechnology,*

Virus induced gene silencing (VIGS) is a powerful tool to study gene function of unknown plant genes and to induce co-suppression by RNA interference with replicating RNA viruses. The expression of genes or gene fragments via VIGS permits gene function analysis and the study of candidate genes in a simple, fast and robust method prior or as an alternative to the transgenic approach. For crops, like cassava, recalcitrant to plant transformation and regeneration, VIGS can be an attractive alternative. For this purpose we have constructed a geminivirus VIGS vector from the genomic DNA A and DNA B components of an East African cassava mosaic virus, cloned within the left and right boarders of a binary vector. The gene to be studied is introduced into the recombinant DNA A genome replacing the viral coat protein which is dispensable for movement in planta. Upon plant inoculation and during infection, the recombinant virus expresses the foreign gene "fragment" and induces the degradation of a homo-/orthologous gene by RNAi. If an endogenous gene is targeted, an altered mutant phenotype resulting from 'gene knock-outs' allows assignment of function to unknown genes. The expression an endogenous cassava magnesium chelatase gene fragment with the replicating virus lead to silencing of the nuclearly encoded sulphur gene significant for chlorophly formation resulting in inhibition of chlorophyll biosynthesis and total bleaching of the plants, hence validating the use of the VIGS system. By using a similar approach, sequences of a destructive cassava infecting RNA virus, Cassava brown streak Ipomovirus (CBSV), were expressed. For this virus not much information is available and there exists no basis of natural resistance in cassava. Hence overexpression of CBSV sequences that results in RNA interference and sequence specific degradation and elimination of infecting CBSV can be an interesting avenue to induce virus resistance. The resistance phenotypes resulting from this approach in different cassava breeding lines infected with CBSV or mixed infected with CBSV and geminiviruses will be presented as examples to discuss the scope of the method.

Keywords: Cassava brown streak virus, Magnesium chelatase Cassava geminiviruses

Contact Address: Stephan Winter, Deutsche Sammlung von Mikroorganismen und Zellkulturen (DSMZ), Plant Virus Division, BBA, Messeweg 11/12, Braunschweig, Germany, e-mail: s.winter@bba.de

Effect of the Application of Antagonistic Fungi with Different Modes of Action for the Control of *Radopholus Similis* in Banana

ALEXANDER R. MENDOZA LUNA, RICHARD A. SIKORA, SEBASTIAN KIEWNICK
University of Bonn, Institute of Crop Science and Resource Conservation-Plant Pathology, Germany

Paecilomyces lilacinus strain 251 (PL251) and the non-pathogenic Fusarium oxysporum strain 162 (Fo162) are well known as biocontrol agents of a range of plant parasitic nematodes. *Paecilomyces lilacinus* is mainly an egg pathogen of sedentary stages of nematodes and the non-pathogenic fungal endophyte Fo162 induces systemic resistance in different host plants. Therefore, the two biocontrol agents with different modes of action were tested for additive or synergistic effects in their potential to control *R. similis* when co-applied to protect young banana plants. The fungal biocontrol agent Fo162 was applied to b anana plantlets (cv.'Grand naine') in a germination tray one and three weeks before transplanting. PL251 was incorporated to a sterilized field soil:sand (1:1) mixture, 6 days before transplanting. The final concentrations of the antagonists were 1×108 and 6×106 cfu g^{-1} soil of Fo162 and PL251, respectively. Both treatments were inoculated with 1000 *R. similis* per plant. Banana plants were harvested 14 days after nematode inoculation. None of the treatments affected root and shoot weight of the banana plants. When applied alone, both biocontrol agents significantly reduced the number *R. similis* per root. The combination of Fo162 and PL251 resulted in a penetration rate that was significantly lower compared to the inoculated control and Fo162 alone, respectively, but not different from PL251 alone. To investigate the interactions between these two biocontrol agents, dual culture in-vitro assays were conducted. In none of the assays negative interactions were found. These preliminary data indicate a potential to combine these biocontrol agents for increased control of *R. similis* on banana.

Keywords: Antagonistic fungi, biological control, endoparasitic nematode, Fo162, PL251

Contact Address: Alexander R. Mendoza Luna, University of Bonn, Institute of Crop Science and Resource Conservation-Plant Pathology, Nussallee 9, 53115 Bonn, Germany, e-mail: mendozaal66@yahoo.com

Can Successive Generations of Banana Plants Be Protected from Nematode Attack by A Single Inoculation with Beneficial Endophytic Fungi?

ALEXANDRA ZUM FELDE[1], LUIS POCASANGRE[2], RICHARD A. SIKORA[1]

[1]*University of Bonn, Institute of Crop Science and Resource Conservation - Plant Pathology, Germany*

[2]*International Network for the Improvement of Banana and Plantain (INIBAP), Costa*

Increasing interest in biocontrol of crop pests for environmental and human health reasons have opened the door to a great variety of potential biocontrol agents from a range of environments. Among these, beneficial bacterial and fungal endophytes, i.e. microorganisms that colonize plant tissue without causing disease symptoms and help protect the plant against diseases or pests, are of special interest. This is in part due to the fact that they can be isolated, re-introduced and re-isolated from the very tissues where pests and diseases are known to attack. In the case of roots and nematodes, this is especially interesting, because an introduction of such beneficial organisms into root tissues prior to planting would avoid the need for soil applications of biocontrol agents in great quantities, as endophytes are already "on site" and ready to protect the crop. Beneficial endophytic fungi have been identified for the management of the burrowing nematode, *Radopholus similis*, in banana. These fungi were isolated from healthy roots of bananas grown in areas where natural nematode suppression was either suspected or proven. Once isolated, fungi were screened for nematode suppression in greenhouse trials and later in field experiments. These experiments proved that the endophytes chosen are effective in protecting banana plants not only at the greenhouse level, but also under field conditions. However, as banana is a perennial crop, with re-plantings occurring only at lengthy intervals, the question of how to protect second and subsequent generations remains. Evidence of a transfer of nematode suppression provided by individual fungal endophytes from one banana generation to the next has been found. This data provides incentives to pursue a long-term nematode-bio-control approach in banana using beneficial endophytic fungi.

Keywords: Biocontrol, *Musa* (AAA), nematode management, suppression, transfer

Contact Address: Alexandra zum Felde, University of Bonn, Institute of Crop Science and Resource Conservation - Plant Pathology, Nussallee 9, 53115 Bonn, Germany, e-mail: zumfelde@uni-bonn.de

Effect of the Application of Antagonistic Fungi with Different Modes of Action for the Control of *Radopholus Similis* in Banana

ALEXANDER R. MENDOZA LUNA, RICHARD A. SIKORA, SEBASTIAN KIEWNICK
University of Bonn, Institute of Crop Science and Resource Conservation-Plant Pathology, Germany

Paecilomyces lilacinus strain 251 (PL251) and the non-pathogenic *Fusarium oxysporum* strain 162 (Fo162) are well known as biocontrol agents of a range of plant parasitic nematodes. *Paecilomyces lilacinus* is mainly an egg pathogen of sedentary stages of nematodes and the non-pathogenic fungal endophyte Fo162 induces systemic resistance in different host plants. Therefore, the two biocontrol agents with different modes of action were tested for additive or synergistic effects in their potential to control *R. similis* when co-applied to protect young banana plants. The biocontrol fungal Fo162 were applied to banana plantlets (cv.'Grand naine') on the germination tray one and three weeks before transplanting. PL251 was incorporated to a sterilized field soil:sand (1:1) mixture, 6 days before transplanting. The final concentrations of the antagonists were 1×108 and 6×106 cfu g^{-1} soil of Fo162 and PL251, respectively. Both treatments were inoculation with 1000 *R. similis* per plant. Banana plants were harvested 14 days after nematodes inoculation. None of the treatments affected root and shoot weight of the banana plants. When applied alone, both biocontrol agents significantly reduced the number *R. similis* per root. The combination of Fo162 and PL251 resulted in a penetration rate that was significantly lower compared to the inoculated control and Fo162 alone, respectively, but not different from PL251 alone. Determination of the rate of root colonisation by Fo162 revealed that in absence of the nematode, the percentage colonized root tissue was significantly reduced due to the application of PL251, but no differences were found when plants were inoculated with *R. similis*. To further investigate the interactions between these two biocontrol agents, dual culture in-vitro assays were conducted. In none of the assays negative interactions were found. These preliminary data indicate a potential to combine these biocontrol agents for increased control of *R. similis* on banana.

Keywords: Antagonist fungi, biocontrol, endoparasite nematode, Fo162, PL251

Contact Address: Alexander R. Mendoza Luna, University of Bonn, Institute of Crop Science and Resource Conservation-Plant Pathology, Nussallee 9, 53115 Bonn, Germany, e-mail: mendozaal66@yahoo.com

Plantain (*Musa spp*. AAB) Bunch Yield and Root Health Response to Combinations of Physical, Thermal and Chemical Sucker Sanitation Measures

STEFAN HAUSER

International Institute of Tropical Agriculture, Humid Forest Eco-regional Center, Cameroon

Plantain is an important staple in West and Central Africa and the Congo basin. The crop is largely grown in extensive 'slash and burn' systems, drawing heavily on the natural resource base, yet it is low yielding due to its high susceptibility to a complex of root and corm pests and diseases. Farmers are unaware of nematodes, banana weevil eggs and fungi and there is virtually no pest and disease control. This study evaluated the effects on plantain bunch fresh yield of factorial combinations of a simple physical sanitation method, paring, followed by five different treatments (control, ash-coating, hot-water treatment, boiling-water treatment and nematicide application). Paring reduced plantain establishment. It had no effect on fresh bunch yields but reduced uprooting and improved root health status. Without previous paring, bunch yields after the traditional ash-coating (5.7 Mg ha^{-1}) and nematicide application (6.3 Mg ha^{-1}) were not different from control (4.6 Mg ha^{-1}). Hot-water treatment (12.0 Mg ha^{-1}) and boiling-water treatment (14.2 Mg ha^{-1}) increased yield significantly. Boiling-water treated plantains attained 90 % of the total yield earlier than any other treatment. Yield losses were mainly caused by pseudostem break. Uprooting caused only minor losses. Yield losses in this study can not be attributed to a particular group of pests or diseases but all factors contributing to water deficiency leading to low turgor permitting pseudostem break. Root health parameters were positively related to bunch yield and to bunch mass per producing plant. Due to its simplicity, flexibility, low cost, absence of negative environmental consequences and the accelerated production boiling-water treatment is the most labour efficient and profitable sucker cleaning method.

Keywords: Cameroon

Contact Address: Stefan Hauser, International Institute of Tropical Agriculture, Humid Forest Eco-regional Center, Cameroon, e-mail: s.hauser@cgiar.org

Biotic Stresses: Biocontrol

Towards Reducing Synthetic Pesticide Imports in Favour of Locally Available Botanicals in Kenya

RHODA BIRECH[1], BERNHARD FREYER[2], JOSEPH MACHARIA[1]

[1] *University of Egerton, Crop Science, Kenya*

[2] *University of Natural Resources and Applied Life Sciences (BOKU), Institute of Organic Farming, Austria*

Pests and diseases are responsible for 30–40 % loss in agricultural produce in the tropics. Unfortunately, these pesticides posses inherent toxicities that endanger the health of the farm operator, consumer and the environment. Kenya imports approximately 7,000 metric tones of synthetic pesticides annually, valued at KShs. 4 billion (US$ 50 million). These pesticides are an assortment of different types. Of the total pesticide imports, insecticides account for about 40 % in terms of volume (2,900 metric tones). The current concern is on the health hazards posed by the presence of these chemicals in the environment. The situation in Kenya is aggravated when cases of pesticide misuse occur due to farmers' ignorance and illiteracy. Kenya is the leading producer of a natural pesticide, pyrethrin, which is a broad-spectrum insecticide made from the dried flowers of *Chrysanthemum cinerariaefolium*. Up to 8,000 tonnes of dried flowers are produced annually. 95 % percent of all the crude pyrethrin is exported to developed countries in the west - 60 % to USA and 35 % to Europe. Only 1 % remains in Kenya. Pyrethrin-based insecticides can well replace most of the imported synthetics. This would reduce the health risk that the synthetics pose. The major problem is that the Kenyan pyrethrins earn a premium price in the more environmentally conscious developed countries so that Kenyans are left with no option but to import the cheaper synthetics or pyrethrin analogs. This scenario raises questions on the willingness and ability of developing countries to pay for better environmental health. This paper recognises research challenges and discusses possible ways through which developing countries can adopt more environmentally friendly agricultural protection measures. These include local pyrethrin preparation at farm level, promotion of locally available botanicals like Neem (*Azadirachta indica*), use of by-products from *Pyrethrum* processing industries, awareness campaigns on safe use of pesticides, favourable government policies, and possible support by multinational chemical companies. Data reported was obtained from interviews with key informants drawn from the Kenya Pesticide Control Board, Pyrethrum Board of Kenya, and local firms, which are major consumers of imported pesticides.

Keywords: Chrysanthemum cinerariaefolium, natural pesticides, pyrethrin, synthetic pesticides

Contact Address: Bernhard Freyer, University of Natural Resources and Applied Life Sciences (BOKU), Institute of Organic Farming, Gregor Mendel Straße 33, 1180 Wien, Austria, e-mail: Bernhard.Freyer@boku.ac.at

Side Effects of Pesticides on Natural Enemies: Selection of Soft Pesticides for the Control of Insect Pests in Sudan

HAYDER ABDELGADER, AHMED MOHAMED
Agricultural Research Corporation, Crop Protection Research Center, Sudan

In the last decades during the post-war period, the agriculture has developed towards methods that are more intensive. Among these is increased use of agrochemicals. In the Sudan Gezira, cotton spraying started as early as season 1945/46 when only 1 % of the cotton area was sprayed once. By 1978/79 the problem caused by the cotton insect pests, particularly the cotton whitefly (*Bemisia tabaci*) flared up. The number of sprays per season went up, reaching 9.25 sprays in season 1978/79, which might be attributed partly to the rapid resurgence of insects' pests as a result of the use of non-selective insecticides, which badly affected the natural enemies of these pests. The joint use of natural enemies and selective pesticides might attribute to combat this problem. Studying the side effects of pesticides is of prime importance to save natural population and encourage their role as biological control agents. This paper discuss the various methods which can be used to study the side effects on natural enemies and the results of some studies carried on the side effects of some insecticides on natural enemies both at small and large scale levels in Sudan. The study include testing the side effects of some insecticides (Talstar, Polo, Metasystox, Marshal and the mixture Reldan + Endosulfan) on two Predators at small scale level at the Gezira Research Farm, Wad medani. The Impact of Polo (diafenthiuron) on natural enemies in the cotton based ecosystem of the Gezira Scheme (Large Scale) was tested in the Study. The results indicated that Polo was relatively safe both at small scale and large scale level to the natural enemies observed during the study.

Keywords: Predators, side effects, Soft insecticdes, Sudan

Contact Address: Hayder Abdelgader, Agricultural Research Corporation, Crop Protection Research Center, P. O. Box 126, Wadmedani, Sudan, e-mail: abdelgaderh@yahoo.com

Effect of Ants in Biological Control of Cassava Green Mite in Africa

BONAVENTURE VIDJINNAGNI AGBOTON[1,2], RACHID HANNA[2], AGNES THOMAS ODJO[3], GEORG GOERGEN[2]

[1]*Georg-August University of Goettingen, Institute of Plant Pathology and Plant Protection, Germany*

[2]*International Institute of Tropical Agriculture, Biocontrol Center of Africa, Benin*

[3]*Université National Bénin, Département des Sciences et Techniques de Production Végétale, Benin*

Interactions between ants and phytoseiid mites have been rarely studied. On cassava plants in Africa, the predatory mite, *Typhlodromalus aripo*, introduced from Brazil to Africa for the biological control of the cassava green mite, *Mononychellus tanajoa*, is frequently found sharing cassava plants and their extrafoliar exudates with several species of ants. That *T. aripo* and ants share space and food on cassava plants may result in interactions that could lead to both direct and indirect effects on their respective abundance and the biological control of *M. tanajoa* by *T. aripo*. As a first step in determining the effects of the presence of ants on *T. aripo* and *M. tanajoa* abundance on cassava, we conducted a series of surveys in 18 farmer-managed cassava fields in southern-Benin where we determined densities of ants, *T. aripo* and *M. tanajoa* on 30 cassava plants in each field. In addition, we conducted a factorial experiment in which we simultaneously manipulated ant and *T. aripo* densities on cassava plants and recorded ant, *T. aripo* and *M. tanajoa* densities. Survey results showed that several ant species in the genus *Camponotus* were most common on cassava plants in southern-Benin. Ant abundance was highest in cassava fields bordered by forest or dense vegetation and when fields were 'weedy', while *T. aripo* was least abundant in weedy cassava fields compared with relatively well-weeded fields. Overall, increasing ant abundance in cassava fields was associated with lower *T. aripo* abundance and higher *M. tanajoa* densities. In the on-station manipulative experiment, ant exclusion had no effect on *T. aripo* and *M. tanajoa* abundance, probably due to low density of the same *Camponotus spp* during the period of the experiment. The failure to show an effect of ant exclusion on *T. aripo* and *M. tanajoa* abundance notwithstanding, the two studies underscore the complexity of trophic interactions in the cassava food web and suggest the need for greater understanding of the interactions between ants and *T. aripo* and the effect of these interactions on biological control of cassava green mite.

Keywords: Ants, biological control, interaction, Mononychellus tanajoa. , Predator mite

Contact Address: Bonaventure Vidjinnagni Agboton, Georg-August University of Goettingen, Institute of Plant Pathology and Plant Protection, Grisebachstraße 6, Goettingen, Germany, e-mail: bagboton@yahoo.com

Potential for Biocontrol of the Diamondback Moth in Myanmar by Using a Predatory Bug

KHIN THEIN NYUNT, STEFAN VIDAL

Georg-August-University Göttingen, Department of Crop Sciences, Entomological Section, Germany

The Diamondback Moth (DBM) is most damaging vegetable pest not only in Myanmar than also in most tropical countries, where cabbage plants and ideal temperatures for high DBM populations prevail throughout the year. Due to frequent insecticide applications development of resistance towards specific compounds, including *Bacillus thuringiensis*, has been reported in several regions. We tested a predatory bug (*Eocanthecona furcellata* — EO), native to Myanmar and commonly found in the field, for its effectiveness to prey on DBM.

We used 2^{nd} instars of EO nymphs and 5 different DBM larval densities. DBM larvae were placed in 9 cm Ø plastic petri dishes and one EO nymph was placed in the centre of each arena; these were then kept at a constant temperature (30° C, 75 % RH and 12:12 L:D) photoperiod in climate cabinets. Larvae consumed per day, larvae still alive and molting date were recorded to adult stage of EO.

The maximum prey consumption per day per EO larvae was surprisingly high and exceeded 9.65 ($\pm$ 0.29) larvae at 30°C in the 5^{th} instar of EO. During the whole lifecycle (2^{nd}N instars to adult), EO was able to consume between 25.50 $\pm$ 2.89 (minimum) and 70.5 $\pm$ 6.35 (maximum) DBM larvae. EO larvae did feed on different lepidopteran species; however, they refused to feed on aphids.

Base on these preliminary data we recommend that the predatory bug *Eocanthecona furcellata* should be tested under field conditions as a biocontrol agent for controlling diamondback moth in Myanmar. Additional research is now done to understand the host spectrum and the ecology of this species.

Keywords: Biological control, *Eocanthecona furcellata*, Diamondback Moth, Myanmar, predatory bug

Contact Address: Khin Thein Nyunt, Georg-August-University Göttingen, Department of Crop Sciences, Entomological Section, Grisebachstr.6, 37077 Göttingen, Germany, e-mail: knyunt@gwdg.de

Control of Post-harvest Disease (*Botryodiplodia* sp.) of Rambutan (*Nephelium lappaceum*) and Annona (*Annona* sp.) by Using a Bio-control Agent (*Trichoderma* spp.) in Sri Lanka

ROBERT KUNZ[1], SHANTHI WILSON WIJERATNAM[2], HANNAH JAENICKE[3], JOACHIM HELLER[1]

[1] *University of Applied Sciences Wiesbaden, Faculty of Geisenheim, Germany*

[2] *Industrial Technology Institute, Post-harvest Laboratory, Sri Lanka*

[3] *International Centre for Underutilised Crops, Sri Lanka*

Recent studies have shown the importance of products of underutilised fruits, such as jams, juices and candied fruits to nutrition, income generation and poverty reduction of small-scale entrepreneurs in developing countries. Underutilised tropical fruits such as rambutan (*Nephelium lappaceum*) and annona (*Annona* sp.) provide important contributions to small-holder livelihoods. However, post-harvest losses are significantly reducing the potential for income generation. While rambutan is consumed as fresh fruit in Sri Lanka and exported in small volumes to Europe, annona is available in smaller quantities in the domestic market where it is consumed fresh or in the processed form as a cordial or ready to serve (RTS) juice. The Industrial Technology Institute (ITI) of Colombo, Sri Lanka, is involved in developing biological control mechanisms for post-harvest diseases of tropical fruits, such as papaya, banana and mango as well as working together with the International Centre of Underutilised Crops on promising underutilised species, such as rambutan, annona and woodapple. The project presented here formed a contribution toward this larger national effort. The stem end rot caused by *Botryodiplodia* is one of the most important post-harvest diseases of tropical fruits. This project used Trichoderma spp. to reduce the disease and to isolate specific strains from several sites within Sri Lanka. In order to confirm previous observations and expand on available data, the study included the isolation of *Botryodiplodia* sp. from infected rambutan and annona fruits and *Trichoderma spp*. from soil at the sites. After successful isolation using Koch's postulates, a series of vitro experiments were conducted to test the antagonistic effect of the biological control agent against the pathogenic organisms. In vivo tests with infected fruit followed. Data will be presented to the effectiveness of *Trichoderma* strains isolated from Sri Lankan soils to control stem end rot on rambutan and annona.

Keywords: *Annona* sp., bio-control agent, *Botryodiplodia* sp, *Nephelium lappaceum*, post-harvest disease, Sri Lanka, *Trichoderma* sp., underutilised fruits

Contact Address: Shanthi Wilson Wijeratnam, Industrial Technology Institute, Post-harvest Laboratory, 363 Bauddhaloka Mawatha, 07 Colombo, Sri Lanka, e-mail: shanthi@iti.lk

Impact of Plant Parasitic Nematodes in Following Suckers on A Root Necrosis Index in Six Commercial Banana Plantations of Costa Rica

ALFONSO CABRERA[1], LUIS POCASANGRE[2], RICHARD A. SIKORA[1]

[1]*University of Bonn, Institute of Crop Science and Resource Conservation-Plant Pathology, Germany*

[2]*International Network for the Improvement of Banana and Plantain (INIBAP), Costa*

The objective of the investigation was to study if a root necrosis index could be used to estimate amount of plant parasitic nematodes on banana roots. The research evaluated correlations between numbers of *Radopholus similis*, *Helycotylenchus multicinctus*, *Pratylenchus spp.*, *Meloidogyne spp.*, or the addition of the four genera per 100 g of functional roots and the root necrosis index described by Speijer and De Waele (1997) in six commercial banana plantations of Costa Rica. With a spade roots were taken ten centimeters in front of following suckers from an excavation of 15 cm long X 15 cm wide X 15 cm depth. Ten banana plants were sampled, mixed in a plastic bag and divided in half of the total root content to consider it as one sample. Samples were taken from high, medium and poor yielding sectors in each farm. Four samples per sector were taken. Roots were gently washed, separated into dead and functional roots, indexed the latter roots and from the indexed ones nematodes were extracted, counted and identified. Results showed that from 30 possible correlations only 8 were found. In some farms high population of nematodes and little root necrosis index was found and vice versa. No nematode genera in particular had a consistent correlation with the index. The study revealed that the root necrosis index evaluated couldn't be used to approximate or estimate amounts of plant parasitic nematodes. Results suggest that the index could reveal much more complex information such as soil chemical, physical and biological status as well as soil management. This index is more useful to give numeric value to root status and be able to compare it between different sites cultivated with banana. The investigation was conducted under the frame of the Banana Soil Health project funded by the Regional Fund for Agricultural Technology (FONTAGRO).

Keywords: Plant-parasitic-nematodes root-necrosis-index banana

Contact Address: Alfonso Cabrera, University of Bonn, Institute of Crop Science and Resource Conservation-Plant Pathology, Bonn, Germany, e-mail: acabrera@catie.ac.cr

Enhancing *Striga* Management Using Pesta Granular Mycoherbicidal Formulations: Synergy Between *Striga*-mycoherbicides and Nitrogen Fertiliser

ABULEGASIM ELZEIN[1], JÜRGEN KROSCHEL[2], GEORG CADISCH[1], PAUL MARLEY[3]

[1]*University of Hohenheim, Institute of Plant Production and Agroecology in the Tropics and Subtropics, Germany*

[2]*International Potato Center, Integrated Crop Management Division, Peru*

[3]*Ahmadu Bello University, Institute for Agricultural Research, Nigeria*

Root parasitic weeds of the genus *Striga* constitute a major biotic constraint to staple food production in Africa, and consequently aggravate hunger and poverty. An integrated approach in which biocontrol represents an important component, appears to be the ideal strategy for reducing *Striga* infestation. Therefore, the synergistic effect between *Striga*-mycoherbicide *Fusarium oxysporum* (isolates Foxy 2 and PSM 197) and nitrogen fertiliser (urea) formulated into Pesta granules, in controlling *Striga* was investigated under glasshouse conditions. Pesta granules were made by encapsulating the inoculum of fungal isolates and urea in a matrix composed of durum wheat-flour, kaolin, and sucrose. Two g of each granular preparation were incorporated pre-planting per pot (4 kg soil) together with *Striga* seeds. An apparent synergistic effect between Foxy 2, PSM197 or of their mixtures and urea, encapsulated into Pesta granules, in controlling *Striga* was observed. All Pesta combinations totally inhibited or significantly reduced the emergence of *Striga* compared to the control, where a steep increase in *Striga* emergence was recorded. Even all the few emerged shoots in the pots treated with fungal mycoherbicide/urea combinations became diseased. None of the emerged plants reached flowering stage, whereas in the control treatment 13 % of the *Striga* plant flowered. All Pesta preparations were very effective, with $\geq$92 % efficacy, indicating similar excellent potential of *Striga* control. When considering the improvement of the sorghum plants, however, the highest increase in the total biomass (85 %) and in the panicle yield (40 %) was achieved with preparation containing the mixture of Foxy2+PSM197+2g urea, confirming the synergistic effect of the fungal isolates and urea. However, the significant reduction in *Striga* emergence and flowering as a result of combining mycoherbicides and urea is an important feature to prevent further *Striga* distribution and infestation. These findings are highly relevant to the realisation of an integrated *Striga* control approach adoptable and applicable by subsistence farmers in Africa.

Keywords: *Fusarium oxysporum*,Mycoherbicide, parasitic Weed, biological control, *Striga hermonthica*

Contact Address: Abulegasim Elzein, University of Hohenheim, Institute of Plant Production and Agroecology in the Tropics and Subtropics, Garbenstr. 13, D-70599 Stuttgart, Germany, e-mail: gasim@uni-hohenheim.de

Farmers' Perceptions of *Imperata cylindrica* and *Chromolaena odorata* Fallows in Cameroon

PROSPER FUAMBENG YONGHACHEA, LINDSEY NORGROVE, RAINER SCHULTZE-KRAFT

University of Hohenheim, Biodiversity and Land Rehabilitation in the Tropics and Subtropics, Germany

The productivity and sustainability of most agricultural practices in the humid tropics of Africa such as Cameroon depends primarily upon the relative rate of soil 'quality' decline during the cropping phase, soil quality regeneration during the fallow phase, and the time allocated to the latter. Due to increased population density and demand for arable land, fallow lengths have been shortened and the ability of fallows to restore soil fertility and suppress aggressive weeds such as *Imperata cylindrica* and *Chromolaena odorata* has become less effective. Therefore, fallows are recropped at a younger age when these species are still dominant. A survey was conducted during April-July 2005 in the North West, South West and Littoral provinces of Cameroon to understand how farmers view and value *Imperata* and *Chromolaena* fallows, and to find out preferred ways of controlling *Imperata* and *Chromolaena* in cropped fields. The common local names allude to *Imperata* as a plant that spears or pierces, and/or typifies unproductive situations. As to local names for *Chromolaena*, the names of unpleasant and aggressive people are used. Farmers' perceived that *Imperata* dominated fallows indicate that soils are poor (34%), soils are only suitable for the cultivation of groundnut and sweet potato (28%), soils are 'hard', i.e. compacted and difficult to till (16%), soils are 'sterile', i.e. very unproductive (13%), and soils are not yet ready to be tilled again (9%). All farmers stated that fallows dominated by *Chromolaena* indicate softer and more fertile soils but require very high labour input for land preparation. Farmers indicated that slashing, deep tillage, rhizome removal, mineral fertilisation, weeding and continuous cultivation could effectively control *Imperata*. They recommend that *Chromolaena* control measures should involve stump removal. Farmers could satisfactorily control *Imperata* and *Chromolaena* but a perceived high labour requirement is seen as limiting factor. The results indicated high weed density and declining soil fertility to be due to unsustainable farming practices rather than shortened fallow lengths. Food availability in Cameroon could be improved by paying more attention to general farming practices.

Keywords: *Chromolaena*, *Imperata*, soil fertility , weed control

Contact Address: Prosper Fuambeng Yonghachea, University of Hohenheim, Biodiversity and Land Rehabilitation in the Tropics and Subtropics, University Hohenheim, 70593 Stuttgart, Germany, e-mail: prosperfy@yahoo.co.uk

Weed Control in Broadcast Rice: Effectiveness of Fenoxaprop-p-ethyl and 2,4-d Mixture

WASANA CHAMKRACHANG[1], SUCHADA VEARASILP[1], PORNCHAI LUEANG-A-PAPONG[1], SONGCHAO INSOMPHUN[1], ELKE PAWELZIK[2]

[1]*Chiang Mai University, Department of Agronomy, Thailand*

[2]*Georg-August-University Göttingen, Institute of Agricultural Chemistry, Germany*

Weed control in broadcast rice was experimented in split-split plot design. Two herbicides spraying at 10 days and 20 days after seeding were main plots. Irrigating 3,6 and 9 days after herbicide treatments were sub plots and 3 rates of fenoxaprop-p-ethyl and 2,4-D mixture 3+100,6+200 and 9+300 g(a.i./a.e.)/rai were sub sub plots. Hand weeding and non weeding treatments were also included as the control treatments. The results indicated that the use of herbicides at 10 days after seeding significantly controlled broadleaf weeds and sedge compared to the 20 days treatment. Irrigation at 3 and 6 days after herbicide spraying showed better effect in weed control than at 9 days after herbicide spraying.Fenoxaprop-p-ethyl and 2,4-D mixture at 6+200 (a.i./a.e.)/rai and 9+300 (a.i./a.e.)/rai were more effective than the rate at 3+100 (a.i./a.e.)/rai.The phytotoxicity was found in the cases of fenoxaprop-p-ethyl and 2,4-D mixture at 3+100 (a.i./a.e.)/rai and 6+200 (a.i./a.e.)/rai which caused slight phytotoxicity whereas 9+300 (a.i./a.e.)/rai resulted in moderate phytotoxicity.The maximum phytotoxicity severity was found at 14 days after application.After 35 days of application the phytotoxicity seemed to have no obviousresults.The results indicated that herbicides spraying at 10 days after seeding got higher yield than the case of 20 days treatment.Irrigation at 3,6 and 9 days after spraying and the three rates of herbicides showed no significant effect on yield and yield components when compared to those from hand weeding but highly significant difference when compared to those from non weeding method.

Keywords: Broadcast rice, hand weeding, herbicide, weed control

Contact Address: Suchada Vearasilp, Chiang Mai University, Department of Agronomy, Chiang Mai, Thailand, e-mail: suchada@chiangmai.ac.th

Water and Forest

Forests for Livelihood

Sustainable Use of Non-timber Forest Products: Pathways Toward Balancing Poverty Reduction and Biodiversity Conservation Goals in Mountainous Southwest China

MARCO STARK[1], YONGPING YANG[2], HORST WEYERHAEUSER[3]

[1]*Center for Mountain Ecosystem Studies (CMES), China*

[2]*Kunming Institute of Botany (KIB), Ethnobotany Department, China*

[3]*World Agroforestry Center (ICRAF), China*

Non-timber forest products (NTFPs) have been defined by the FAO as goods of biological origin other than wood, derived from forests, other wooded land and trees outside forests. NTFPs have attracted considerable interest in rural development initiatives in recent years due to their ability to support and improve rural livelihoods while contributing to environmental objectives, including biodiversity conservation. However, in spite of more than a decade of research and targeted development projects, systematic understanding of the role and potential of NTFPs in conservation and development remains weak. Among the many non-timber forest products that are being extracted by rural households from natural and planted forests in mountainous Southwest-China, mushrooms, medicinal plants, walnuts, pine nuts, wild vegetables, eucalyptus oil and honey play an important role in the household economy. Institutional arrangements aimed at the sustainable utilisation of NTFPs in communal forests only exists for a few more valuable products threatened by over-exploitation, such as the Matsutake mushroom.

Studies conducted at the Center for Mountain Ecosystem Studies (CMES), a joint Center of the Kunming Institute of Botany and the World Agroforestry Center point to important knowledge gaps that may lead to serious exploitation and unsustainable use of the natural resource "NTFP", such as: **(1)** lack of basic knowledge on germplasm and non-existing or incomplete inventory; **(2)** no institutional arrangements to ascertain sustainable extraction levels; **(3)** insufficient market transparency for communities' (in terms of quality, price, markets for NTFPs); **(4)** insufficient knowledge of NTFP domestication and little understanding of the effects of domestication on product quality and price and the conservation of wild sources; and **(5)** no existing research on the full length of the commodity chain for major non-timber forest products and the various actors in the chain.

This paper discusses in particular the potential of certification of NTFPs under organic, ecological and fairtrade schemes as a pathway toward balancing poverty reduction and biodiversity conservation goals in China's remote mountain regions.

Keywords: Commodity chain analysis, organic and fairtrade certification, Yunnan

Contact Address: Marco Stark, Center for Mountain Ecosystem Studies (CMES), C/o Kunming Institute of Botany (KIB), Heilongtan, 650204 Kunming, China, e-mail: m.stark@mail.kib.ac.cn

Conservation and Use of Wild *Coffea arabica* Populations in the Montane Rainforests of Ethiopia

MANFRED DENICH, FRANZ GATZWEILER, TADESSE WOLDEMARIAM

University of Bonn, Center for Development Research (ZEF), Germany

Coffea arabica originates from southwest and southeast Ethiopia where wild Arabica coffee grows as a small tree in the understory of the montane rainforests. The wild coffee populations are highly endangered by deforestation due to the demand for agricultural land and settlement areas. This development is alarming as wild coffee is not only consumed by local people, but it is also an important cash crop on local markets as well as the international specialty market. Above all, it is an invaluable genetic resource for national and international coffee breeding in the future.

Floristic and molecular-genetic studies show the high species diversity of the montane rainforest and the high genetic diversity of the wild coffee populations, respectively. Eco-physiological studies indicate site-specific differences in the water-use efficiency and drought-stress tolerance of wild coffee populations. Research on fungal pathogens, such as coffee leaf rust and coffee berry disease, reveals disease-tolerant wild coffee plants. Wild coffee collection by local people is based on traditional use rights rather than on governmental regulations for forest access. The global potential economic value of the Ethiopian coffee-genetic resource for breeding was estimated between US$ 0.5 and 1.5 billion. For transferring the research findings into practice, the Ethiopian Coffee Forest Forum was established. In collaboration with scientists on the one hand, and policy makers, politicians, the authorities and local people on the other, it develops approaches for the conservation and use of wild *Coffea arabica* in the montane rainforests.

An overview of the research approaches and the possibilities for the implementation of research-based conservation and use concepts for wild coffee in its forest habitat will be given.

Keywords: Biodiversity, deforestation, economic value, genetic diversity, non-governmental organisation, protected area, species diversity

Contact Address: Manfred Denich, University of Bonn, Center for Development Research (ZEF), Walter-Flex-Straße 3, 53113 Bonn, Germany, e-mail: m.denich@uni-bonn.de

Payments for Forest Environmental Services How Much Do We Really Have to Pay?

TOBIAS WÜNSCHER[1], STEFANIE ENGEL[2], SVEN WUNDER[3]

[1]*ZEF - Centre for Development Research, University of Bonn, Germany*

[2]*Swiss Federal Institute of Technology Zurich (ETH), Switzerland*

[3]*Centre for International Forestry Research (CIFOR), Brazil*

One of the causes of extensive worldwide forest loss is the lack of internalisation of indirect forest benefits into the decision-making process of the forest owner. In an attempt to create markets and consequently a price for these services an instrument called Payment for Environmental Services (PES) has become widely acknowledged and increasingly popular. International stakeholders participate in these newly created ´markets´ in order to secure global environmental services such as biodiversity conservation and carbon mitigation. In many cases it is especially the poor who benefit from these payments in marginal but forest rich areas. However, despite being a market-based instrument most PES programs are centrally organised with structures similar to a monopsony. The price, therefore, is largely controlled by the central agent and as a result its determination becomes a highly disputed political and social issue. We intend to contribute with an economic perspective to the discussion and compute minimum farm-scale payments on the basis of economic data from a field survey conducted with 178 land owners on Nicoya Peninsula, Costa Rica. We compare three different approaches for price determination: i. opportunity cost of forest conservation based on monetary flows; ii. willingness to accept (WTA), iii. land sale values. Preliminary results show, as expected, differences in the computed payments between and within approaches. Unexpectedly, differences between approaches do not always follow a general pattern and cannot be predicted on the basis of our data. This not only questions the applicability of the approaches but also the use of a uniform payment. As the provision of environmental services also varies greatly between land porperties, a combination of information on minimum payments and spatially differentiated service provision could increase significantly the amount of environmental services bought with a fixed budget. We therefore propose auction systems as a forth alternative for price determination. Even though more complex, they stimulate the service provider to reveal real accetable payment levels and give the service buyer the opportunity to maximise environmental services per dollar spent. Auction systems are a step towards creating real markets for environmental services.

Keywords: Auction system, costa Rica, economic incentives, environmental services, market based

Contact Address: Tobias Wünscher, ZEF - Centre for Development Research, University of Bonn, Walter-Flex-Straße 3, 53113 Bonn, Switzerland, e-mail: tobias.wuenscher@uni-bonn.de

A Biophysical Approach to the Environmental Services by Land-use Systems Assessment; Functional Biodiversity in Tropical Agroforestry Systems (The Case of Tome-acu Community, Northern Brazil)

DANIEL CALLO-CONCHA, MANFRED DENICH, PAUL L. G. VLEK
University of Bonn, Center for Development Research (ZEF), Germany

Currently, the environmental services concept and its assessment seems the most appropriate approach to estimate, evaluate, conserve and in general make environmental use sustainable The most well known environmental services are water purification or carbon sequestration. However, there are knowledge gaps. In the case of biodiversity, for example, evaluation has mostly been based on quantitative or qualitative studies of individuals and functional groups.

We suggest functional biodiversity as an indicator for the sustainability of land-use systems, as it is closely related to the variability, resilience and dynamics of ecosystems.

The application of the Criteria & Indicators (C&I) approach addresses this intention, operationalizing the functions involved in three main clusters: productive, ecological and operational through the definition of a sufficient number of indicators to represent the most relevant interactions. Such indicators are mainly process based and underline the impact of human intervention on ecosystems.

In this framework, the objective of this research is to assess the factors influencing the biophysical processes that determine the capabilities of agroforestry systems to maintain functional biodiversity, underlining the importance of the management factor to make them more productive and sustainable.

The data collecting methods include: ecological field studies, interviews, secondary sources review supported by remote sensing approaches. The units of analysis are agroforestry plots in small farmer properties; data processing is supported by multi-criteria protocols: workshops at different levels of target groups and specialised software (CIMAT 2.0). The results will be used to develop a model of the agroforestry systems for deeper understanding and to support decision making by the farmers.

Keywords: Agroforestry Systems, Biophysical assessment, Criteria & Indicators, Environmental Services, functional biodiversity, Tropics

Contact Address: Daniel Callo-Concha, University of Bonn, Center for Development Research (ZEF), Walter-Flex-Str. 3, 53113 Bonn, Germany, e-mail: dcalloc@uni-bonn.de

Is Community Forestry Beneficial for Poor? : impact Analysis of Community Forestry on Livelihoods of Forest Users in Nepal

PREM RAJ NEUPANE[1], ARCHANA GAULI[1], NETRA BHANDARI[2]

[1]*Georg August University, Tropical and International Forestry, Germany*

[2]*University of Hohenheim, Department of Agricultural Communication and Extension, Germany*

The critical role of CF for fostering social and economic development in Nepal has been widely recognised. It has also been argued that CF programme is essentially a strategy adopted to bring about socio economic change and development in rural areas. According to community forestry framework in Nepal, Community Forest Users Groups (CFUGs) are entitled to collect revenues from the forest products. Funds generated by CFUGs have been used not only for the management of their forests, building village level infrastructures such as rural roads, small water supply schemes, irrigational canals and schools; but also for conducting income generating activities for the users. This indicates that CF holds potentials for rural development as well as poverty alleviation in Nepal.

This study was conducted to explore the impacts of CF on livelihood of Ranipani CFUG, Tanahun, Nepal. The indicators observed to asses the impact of CF were based on different assets viz. Physical, Natural, Human, Social and Financial. The CF contributions were compared in terms of forest product supply situation, number and feeding techniques of livestock, forest products availability and time required for collection of the products. The participation and perception of users in decision-making have been assessed with respect to different well-being categories.

The results show that CF contributes to user livelihood by meeting the basic needs for forest products, easy availability of forest products by reducing the time for collecting forest products, encouraging to adopt productive livestock and stall-feeding, and this all leads to improved living condition of the users. The study observed that the time required for collecting fodder was reduced by 56 % and fuelwood by 50 % in the year 2003 compare to the base year 1996. Similarly, livestock unit has been increased by 24 % per household. Study suggests that 60 % of the CFUG members adopted stall-feeding shifting their open grazing practices.

The research concluded that the present practice of Ranipani CF plays a fairly significant role in capital formation, environmental sustainability, institutional development and its sustainability, in the process of community empowerment and social change and the reduction of vulnerability.

Keywords: Community forest user group, community forestry, livelihood, Nepal

Contact Address: Prem Raj Neupane, Georg August University, Tropical and International Forestry, Albrecht Thaer Weg 10 B/103, 37075 Goettingen, Germany, e-mail: prem_tif@yahoo.com

Institutional Structures and Performance of Community Forest Management: the Case of Vietnam

TUAN DO ANH, JÜRGEN PRETZSCH

Technische Universität Dresden, Institute of International Forestry and Forest Products, Germany

In the last decades, in respond to the increasing rate of forest cover loss, community forest management (CFM) has been widely considered as a promising forest management system in many developing countries. In this context, local institution (rule) systems for forest management have gained considerable attention of many scholars. However, the debate on what institutional structures are appropriate for community forest management is still going on. In Vietnam, CFM models are rather diverse in origin and can be grouped into two major institutional structures. The first is village forest management (VFM), in which all households of a village belong to a forest management group. The second is forest user group (FUG), formed by a small number of households, a subset of a village. The objective of this study is to comparatively analyse the performances of CFM models under these institutional structures and to identify the determinants affecting the performance. Eleven CFM models were selected at Hoa Binh, a mountainous province in the North of Vietnam. In-depth comparative case study was chosen as the research approach, and both Rapid Rural Appraisal and household interview methods were employed. Multi-criteria approach was applied for evaluating the performance in aspects of efficiency, equity, and sustainability. The study results show that the performance of the FUG models is higher than that of the VFM models. Group size and linkage between local groups and local authorities are two key determinants. The communal forests governed by the small-sized groups, which are nested under the control of local authorities are better managed than the forests governed by the large sized groups operating almost independently. From the findings, it is recommended that under the context of the study area, the FUG institutional structure is more appropriate, and supportive participation of local authorities is necessary for the success of community forest management.

Keywords: Community forest management, institutional structure, Vietnam

Contact Address: Tuan Do Anh, Technische Universität Dresden, Institute of International Forestry and Forest Products, Pienner Str. 7, 01737 Tharandt, Germany, e-mail: dotuan71@yahoo.com

Options for the Sustainable Development in Humid Mountain and Semi-arid Surrounding Areas in Ceará, Brazil

HARTMUT GAESE[1], MARC J. J. JANSSENS[2], JUAN CARLOS TORRICO[2], SABINE SCHLÜTER[1], SANDRA MARIA GUIMARAES CALLADO[2]

[1]*University of Applied Sciences Cologne, Institute for Technology in the Tropics, Germany*

[2]*University of Bonn, Institute of Crop Science and Resource Conservation - Tropical Crop Production, Germany*

The Baturité region in the North of Ceará presents a singular climatic diversity and is divided in three sub-regions of a total of 3,822 km^2: humid highlands and semi-arid surroundings (Sertão) and the transition zone inbetween. This mountainous region called "Maciço de Baturité" has fundamental ecological importance for the formation and maintenance of the hydrological stability, specifically for the supply of the metropolitan region of Fortaleza, a city of over 2 Mio inhabitants. The biodiverse forests are encroached by agricultural land-use. Agricultural production systems are characterised by low technological levels which threaten the stability of the natural systems. Population growth is high; the young people emigrate to the cities in search of better economic possibilities; though geographically close, markets are not being reached by the majority of farmers, and the commercialisation system is inefficient. Innovative agricultural production systems were evaluated both from economic and ecological point of view together with their social implications. These alternative systems are ecological and integrated, for instance organic coffee, intensive floriculture, intensive horticulture, sheep-goats, and beekeeping throughout suitable for family farms. The "Maciço of Baturité" has an enormous potential as a pilot area for regional development. The fragility of the natural systems and the threats to scarce water resources of the three sub-regions demands urgent planning and investigation. Future development should make benefit of the location advantage of the proximity to the large consumer market of Fortaleza. It is important to promote the controlled tourism included the other 12 neighbours municipalities as a base for the economic and productive impulse and to counteract socio-economic regression. Specific strategies for each environment can be proposed: Motivating young people, applying an integrated farming system approach, further improvement of flower and vegetable cultivation, inputs to be reoriented towards local resources, development of local markets, linking tourism with coffee production, restricting coffee production to quality cultivars within quality environments.

Keywords: Baturité, key words: Ceará, options for sustainable development.

Contact Address: Juan Carlos Torrico, University of Bonn, Department of Tropical Agriculture, Bonn, Germany, e-mail: torrico@web.de

People or the National Park an Ethnography of Forest Devolution in Vietnam

XUAN PHUC TO

Humboldt-Universität zu Berlin, Junior Research Group Postsocialist Land Relations, Germany

The government of Vietnamese started to implement forest devolution policy in the 1990s by which it shifted the control over the forest from the state to the hand of local villagers. Under the new situation, the bundle of rights over the forest and duration of those rights are substantially expanded. The government expects that by giving villagers more rights in longer duration, villagers would invest more in land and consequently they will receive higher return from their investment. Forest cover thus will increase simultaneously. This paper uses property conceptual framework as a lens to look at access to forest resources in the uplands of Vietnam. It examines changes in property landscape in an upland village located in the buffer zone of a National Park. There have been a lot of changes regarding social unit, property object, legal institutions and property ideology during and after implementation of devolution policy. The implementation of the devolution policy is strongly influenced by global concern about biodiversity conservation, market force on landscape value and local power relations. At local level, those who have access to political power (local elite) are the ones who capture most of benefit from the devolution. By contrast, villagers find themselves in a losing side, having no choice but tie to local elite on a patron-client basis to gain access to cultivated land. Forest then becomes the place for villagers to express their discontent to the local authorities and local elite. Unexpectedly, the implementation of the devolution policy worsens local livelihoods and exacerbates environmental condition.

Keywords: Forest Access, National Park, Vietnam

Contact Address: Xuan Phuc To, Humboldt-Universität zu Berlin, Junior Research Group Postsocialist Land Relations, Luisenstr. 56, Berlin, Germany, e-mail: txphuc2001@yahoo.com

Farmers' Benefits in Different Value-chains of Non-timber Forest Products in China

JULIA SCHMITT, VOLKER HOFFMANN

University of Hohenheim, Department of Agricultural Communication and Extension, Germany

Non-timber forest products (NTFPs) are critical to most rural livelihoods in developing countries. Therefore, commercialisation of NTFPs has been widely supported to achieve rural development and poverty reduction, as anticipated in the Millennium Development Goals. However, many initiatives have failed to fulfil these expectations. In fact, the benefits rural populations receive from selling NTFPs are often minimal compared to benefits received by other stakeholders in respective value-chains. Subsequently, alternative schemes, such as fair trade, social and organic certification, as well as, ecological and ethnical branding are currently promoted as the means to ensure that NTFP commercialisation makes a positive contribution to the livelihoods of the rural poor. Achieving fair benefits from NTFPs is particularly important in China, where the utilisation of NTFPs, i.e. mushrooms, herbal medicine, bamboo, vegetables and many more, has a long history and markets are well established. To date, China processes and trades more wild products than any other country, thus dominates world trade in NTFPs. Yet, the overlap between severe poverty provinces and provinces with abundant forest resources is still significant in China. In the framework of a German-Chinese research project between the World Agroforestry Centre in China (ICRAF-China) and Hohenheim University, the benefits of collecting and producing NTFPs within different value-chains are examined. In particular, the benefits for small-scale farmers connected to different NTFP value-chains will be evaluated to assess if the benefits of alternative schemes for NTFPs actually justify the participation of poor rural household in China. The study is conducted in North-Western and South-Western China, in two of the poorest provinces, i.e. Gansu and Yunnan, by applying socio-economic surveys in the study sites, a market survey and value-chain analyses of selected key NTFPs within the following two years.

Keywords: China, non-timber forest products, value-chains

Contact Address: Julia Schmitt, University of Hohenheim, Department of Agricultural Communication and Extension, Hohenheim, Germany, e-mail: jschmitt@uni-hohenheim.de

Domesticating Wild Non-wood Forest Products (NWFPs): Opportunities of Alternative Farming for Rural Livelihoods in Nepal

NETRA BHANDARI[1], BABURAM RIJAL[2], BHARAT BHUDTHAPA[3], JEETENDRA MAHAT[3], MOON RAWAT[3], SHYAM LAL MAHAT[3], SHER BAHADUR ROKAYA[4]

[1]*University of Hohenheim, Department of Agricultural Communication and Extension, Germany*

[2]*Georg-August-University Göttingen, Tropical and International Forestry, Germany*

[3]*Ministry of Forest and Soil Conservation, Department of Forest, District Forest Office, Jumla, Nepal*

[4]*Tribhuvan University, Institute of Forestry, Nepal*

Non- wood forest products (NWFPs) contribute substantially to the livelihood systems and local economies of rural societies in Nepal. NWFP cultivation is not an established trend in Nepal. Bringing NWFPs domestication as cultivation practice is a challenging task. However, in addition to Jatamansi, many experiments were made to domesticate some valuable NWFPs like Atis, Bojho, Sugandhawal, Chiraito, Keshar etc. in Karnali zone in the past decades. NWFP cultivation in Jumla has been successfully conducted since couple of decades, but it is limited as a domestication trial only and has not yet been brought on commercial scale. The study was conducted in Jumla district from 2003 to 2005. Study aimed to assess the profitability in trading, economic cultivation and market opportunities of *Nardostachys grandiflora*. It also assessed the investment feasibility of Jatamansi cultivation and assessed the attitude and preference of people toward Jatamansi Cultivation. Participatory methods were employed together with cost benefit analysis of agricultural crops and Jatamansi in the study. The results show that the greatest net present value (NPV) at the 12 % discount interest rate is possible from Jatsamansi cultivation than NPV of agricultural crops. NPV received from the Jatamansi cultivation is 1.27 times greater than that of the agricultural crops. This means, at present time, farmers are getting involved in less profitable cultivation of the conventional agricultural crops. Even though, the feasibility of investment on the cultivation of Jatamansi is not economically justified, the attitude of people towards cultivation of NWFPs is extremely positive, while its demand in the market is high and it can be immediately sold to the local traders. Major factors responsible for hindering the cultivation of Jatamansi are lack of land followed by maturity period, lack of appropriate techniques, lack of seed and the market price fluctuation. More than 28 % respondent realised that lack of land is the major constraints in expanding Jatamansi cultivation, where as 24 % realise that maturity period of more than 5 years is a major cause that they cannot opt for Jatamansi cultivation. There is a room for maximising the net profit by adopting Jatamansi cultivation.

Keywords: Community forest, cost benefit analysis, cultivation, domestication, *Nardostachys grandiflora*

Contact Address: Netra Bhandari, University of Hohenheim, Department of Agricultural Communication and Extension, Schloß, Museumsflügel 120PC, 70599 Stuttgart, Germany, e-mail: bhandari@uni-hohenheim.de

Improving the Livelihood of the Rural Population in the Ashanti Region in Ghana through the Implementation of an Improved Taungya System with Teak and Albizia

JÖRN STRUWE[1], JÖRN ACKERMANN[2], REINHOLD GLAUNER[1], JOBST-MICHAEL SCHROEDER[1]

[1]*Fed. Research Centre for Forestry and Forest Products, Institute for Worldforestry, Germany*
[2]*Centrum für Internationale Migration (CIM), Germany*

The agricultural landscape in the Ashanti Region of Ghana is dominated by mainly small scale subsistence farming with annual crops like maize, maniok, yam, beans, etc. An eventual surplus is sold on local markets to gain income. The yield and income of the farmers are constantly threatened by degradation of land and soil due to annual fires and non-diversified agricultural systems. An alternative to the traditional unsustainable farming system is the establishment of agroforestry systems which enable permanent agriculture, diversify production as well as risks and offer chances for an improved market access. The Institute for Worldforestry 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. The purpose of this cooperation is to improve the livelihood of the local rural population within the surroundings of the plantation sites and simultaneously safeguard and expand the plantation sites in an economically and ecologically sustainable way. A tree "outgrower" programme based on the Taungya System has been developed and is being introduced to farmers in the surroundings of the plantation sites. Farmers interested in the programme become trained in workshops in order to attain necessary working skills. They are offered teak (*Tectona grandis*) and albizia (*Albizia falcataria*) seedlings for free which they plant on their land together with their preferred staple crops. In addition, seedlings of genetically improved fruit trees (orange, mango, oil palm, cashew) are provided and preferrably planted on the outer boundaries of the farm land. The task of the farmers is to prepare and maintain the farming system. All harvest products (crops, fruits, timber) belong to them. Thus, farmers have the opportunity to develop a permanent income. The timber company has the right to be the first bidder for the timber when maturity is reached after assumed 10 to 15 years. Further investigations will evaluate the effects of the programme in regard to sustainability, improvements of the rural livelihood and income generating.

Keywords: Agroforestry, Ghana, taungya, teak

Contact Address: Jobst-Michael Schroeder, Federal Research Centre for Forestry and Forest Products, Institute for World Forestry, Leuschnerstraße 91, 21031 Hamburg, Germany, e-mail: j.m.schroeder@holz.uni-hamburg.de

Economics of in Situ Conservation of Indigenous Trees by Smallholder Farmers in Central Malawi

THORBEN KRUSE[1], HERMANN WAIBEL[1], FESTUS K. AKINNIFESI[2], DAGMAR MITHÖFER[3]

[1]*Leibniz University of Hannover, Development and Agricultural Economics, Faculty of Economics and Management, Germany*

[2]*World Agroforestry Centre (ICRAF), SADC - ICRAF Programme, Malawi*

[3]*International Centre of Insect Physiology and Ecology (ICIPE), Kenya*

Indigenous trees play major roles in the rural livelihood of communities in Sub-Saharan Africa, particularly in terms of their environmental service function and contribution of tree products to the rural household economy. However, the high rate of deforestation in Malawi raises concerns on the sustainability and future supply of these natural resources. A case study was conducted in Dedza district in central Malawi during 2005 to investigate conservation of semi-wild indigenous trees growing and retained at the farm, homestead and dimba fields. The study aims at identifying factors influencing conservation and the use/ non-use of conservation practices of indigenous trees. A total of 133 rural households were interviewed in two geographically and socio-economically different Extension Planning Areas (Kanyama and Linthipe) of Dedza district. Structured questionnaires were used to collect data on demographic, farm household, tree crop and institutional support issues, which are considered to influence the adoption process. Data were analysed by logistic regression analysis. Results show that farm households in Linthipe cut indigenous trees more frequently than in Kanyama. Also, a higher share of farm households in Linthipe uses indigenous tree products as an additional source of cash-income. Consequently, tree resources are scarcer in Linthipe. In addition, the household sizes in Linthipe increases the pressure on the trees. Indigenous tree conservation practices vary between the two locations in form and intensity. Expected factors associated with these differences are socio-economic factors, e.g. consumer- worker ratio and external factors like the distance to markets. The result of this study will give information on the status of conservation of indigenous trees in Malawi and factors that are associated with the decision to conserve the trees. The results will provide input to strategies of non-governmental and governmental organisations that aim at halting the ongoing environmental degradation in Malawi.

Keywords: Conservation practices, *In situ* conservation, indigenous trees, Logistic Regression

Contact Address: Thorben Kruse, Leibniz University of Hannover, Development and Agricultural Economics, Faculty of Economics and Management, Humboldtstr. 27, 30169 Hannover, Germany, e-mail: thorbenkruse@web.de

Towards Improved Utilisation and Conservation of the Multipurpose Tree *Cordia dodecandra* in Yucatan, Mexico

JOSU ITURBE[1], JUAN J. JIMÉNEZ-OSORNIO[2], PETR KARLOVSKY[1], HOLM TIESSEN[1], BRIGITTE L. MAASS[1]

[1]*Georg-August-University Göttingen, Department of Crop Sciences, Germany*

[2]*Universidad Autónoma de Yucatán, Departamento de Manejo y Conservacion de Recursos Naturales Tropicales (PROTROPICO), México*

The tree 'Ciricote' (*Cordia dodecandra*: Boraginaceae) is distributed naturally in Mexico, Guatemala, Belize and Honduras, where it is an important component of dry tropical forests and thickets. This traditional multipurpose tree is frequently found in Maya homegardens and plays an important role for livelihoods. The edible fruits are used to make preserves and jams, among others. Its yellow colour with dark red streaks makes the wood valued in manufacturing furniture and handicrafts. Occasionally its value is even higher than that of mahogany. Therefore, Ciricote can constitute an additional source of income for smallholders. As severe deforestation and land use change took place in much of Central America, the few natural stands of Ciricote left are threatened by genetic erosion. Because of its environmental adaptation and economic potential, however, Ciricote has been considered an appropriate species to reforest substantial areas of degraded land in Yucatan. However, there is hardly any information available about the provenance of planting material used in nurseries or the genetic structure of populations in general. Therefore, the present study focuses on estimating levels of genetic diversity in Ciricote by using both morphological traits related to wood and fruit characteristics as well as molecular markers, AFLPs in this case. Overall six Ciricote populations isolated from each other, two each from the states of Campeche, Quintana Roo and Yucatan have been characterised. Leaf samples have been collected from about 25 trees per population for laboratory analysis. Comprehensive data analysis by multivariate statistical procedures has been performed. The GIS-base computer tool FloraMap has been applied to predict both the distribution of Ciricote in the wild and its potential climatic adaptation. Results may, therefore, assist in selecting most appropriate germplasm for the promotion of Ciricote as well as areas climatically suitable for reforestation. Due to the better understanding of the diversity contained in populations, on the other hand, it is likely that the conservation of this multipurpose species will be improved through its utilisation.

Keywords: Agroforestry, genetic resources, molecular marker, multipurpose tree, underutilised crop

Contact Address: Brigitte L. Maass, Georg-August-University Göttingen, Department of Crop Sciences, Grisebachstr. 6, 37077 Göttingen, Germany, e-mail: bmaass@gwdg.de

Agroforestry and Forest Assessment

Production Potential and Ecosystem Quality of Secondary Forests recovered from Agriculture - Tools for Landuse Decisions

CARLOS ALBERTO RUIZ GARVIA, HOLM TIESSEN, MARTIN WORBES
Georg-August-Universität Göttingen, Institute of Agronomy in the Tropics and Subtropics, Germany

Forest fallow in large areas of Semiarid Americas plays a vital role in the maintenance of land quality and are also important for the community. The total benefits of ecosystem services provided by forest fallows and the potential for forest production have not been evaluated, largely because forest productivity under secondary land cover has rarely been measured with an eye to marketable products. We here explored options for improved landuse management in secondary forest in Northern Yucatan, Mexico. We measured nutrient budgets in soils and vegetation and use tree-ring analysis to predict tree productivity in fallow vegetation of different succession states. Cross dating techniques were used to identify correlation between tree growth and climatic patterns. Furthermore, trials were established to identify limiting factor in soils.
Overall fertility may be lower in young secondary forest. Unlike the other indices of fertility, K levels were significantly higher in young forest which may indicate translocation functions of plants when K becomes limiting factor. This result is consistent with more rapid turnover of organic matter or greater amounts of material cycling through the forest floor litter layer.
Tree species of young secondary forest showed the higher mean annual diameter increment than those from old secondary forest. Tree ring analysis for core-samples of *Cordia dodecandra* and *Piscidia piscipula* showed a positive relation with the annual rainfall and total precipitation in the rainy period. In *Piscidia piscipula* the mean ring-widths vary between 0.8 mm per year whereas in *Cordia alliodora* 0.6 mm per year. Tree species of young secondary forest show higher annual increment with 1.2 mm per year than old secondary forest.

Keywords: Landuse change, secondary forest, soil quality, tree ring analysis

Contact Address: Carlos Alberto Ruiz Garvia, Georg-August-Universität Göttingen, Institute of Agronomy in the Tropics and Subtropics, Grisebachstraße 6, 37077 Göttingen, Germany, e-mail: cruiz@gwdg.de

Effects of Grazing Intensity on Selected Trees and Shrubs in Subandean Silvopastoral Systems in Bolivia

ANDREA CORINNA MAYER[1], SVENJA MARQUARDT[2,1], HÉLÈNE LAURENCE BOUILLOT[1], MARTHA SERRANO[3], STEPHAN BECK[4], HUMBERTO ALZÉRRECA[4]

[1]*ETH Zurich, Institute of Animal Sciences, Switzerland*

[2]*ETH Zurich, Swiss Federal Institute for Snow and Avalanche Research, Switzerland*

[3]*Herbario de La Universidad Mayor de San Andres, Bolivia*

[4]*Programa Estratégico de Acción para la Cuenca del Río Bermejo, Bolivia*

The mountain forests of the Bolivian Subandino are traditionally used for cattle grazing. Large parts of these silvopastoral areas are located in regions dedicated to nature conservation, and there is concern that cattle grazing may alter plant species composition and vegetation structure of the forest. There does not exist published knowledge concerning cattle diet in Subandean forests and the impact of different cattle stocking rates on forest vegetation. In a controlled grazing experiment, the effect of different cattle stocking rates on the intensity of browsing on trees was assessed. In the community of Salinas, Department of Tarija, Bolivia, inside the Reserva Nacional de Flora y Fauna Tariquia, an experimental area divided into three parcels of 100m $\times$ 300 m each, consisting in one third open pasture and two thirds forest (Bosque Montano Tucumano-Boliviano), was established. The parcels were stocked with different numbers of cattle: i) cattle stocking rate typical for the region (total animal weight 1286 kg); ii) cattle stocking rate significantly lower than usual (694 kg); iii) cattle stocking rate significantly higher than usual (2001 kg). Naturally regenerated trees (427 plants of 9 species) were selected, and the browsing intensity was assessed once per week during six weeks, using a scale of five levels based on the measurement of shoot lengths and numbers of leaves. The woody plants of the parcel with the highest cattle stocking rate were browsed significantly more intensely (25–50 % browsed) than the woody plants in the parcels with lower cattle stocking rate (1–25 % browsed). The plant species browsed most intensely was the shrub *Piper amalago* (between 25 % and 50 % browsed), followed by the tree species *Allophylus edulis*, *Cedrela sp*., *Diatenopteryx sorbifolia* and *Chrysophyllum gonocarpum*; *Barnadesia odorata*, *Celtis iguanaea* and *Patagonula americana* were browsed less intensely by the cattle; the latter was browsed only in the parcel with the highest stocking rate; *Myrciaria floribunda* was not browsed at all. Since the cattle mainly browsed on species with tender leaves, these plant species might be most threatened by grazing cattle.

Keywords: Andes, forest grazing, livestock nutrition, silvopastoralism

Contact Address: Andrea Corinna Mayer, ETH Zurich, Institute of Animal Sciences, Universitätsstrasse 2, Zurich, Switzerland, e-mail: andrea.mayer@inw.agrl.ethz.ch

Development of Trees in Sylvopastoral System in Eastern Brazilian Amazon: Establishment Phase

CÉLIA MARIA BRAGA SARMENTO[1], JONAS BASTOS DA VEIGA[2], SILVIO BRIENZA JUNIOR[2], OSVALDO R. KATO[2], ARI PINHEIRO CAMARÃO[2]

[1]*Rural Federal University of Amazon, Brazil*

[2]*Brazilian Agricultural Research Corporation (EMBRAPA), Brazil*

In the Brazilian Eastern Amazon, the productivity of pastures established by slash-and-burn (SB) is reduced with the time, leading to a process of pasture degradation. The sylvopastoral systems (SPS) that integrate pasture and trees can increase the sustainability of that land-use. This study object to evaluate the pasture and four trees performance in SPS in Igarapé-Açu, State of Pará, Brazilian Eastern Amazon (1o 6' S and 47o 31' W). The soil is a sandy Latossolo Amarelo of low fertility. In 2001, a *Brachiaria brizantha+B. humidicola* pasture was established in two areas of 2.4 hectares of a 10-year-secondary vegetation, with a biomass of 74 tMS ha—1. In one of the areas, the land was prepared by SB method and another by slash-and-trituration/mulch (STm) method. Both areas have been used in a grazing experiment (18 days of grazing, 36 days of rest, three paddocks). In march 2004, in three paddocks (50 m $\times$ 53 m) of each method a trial of tree performance in SPS was superimposed. In each paddock seedlings of *Schyzolobium amazonicum*, *Tectona grandis*, *Khaya ivorensis* and *Bertholletia excelsa* were planted, each in one line of 50 m, 5 m apart. The distance between lines was 8 m. From April 2004 to April 2006, the height and the stem base were measured each two months. In this phase establishment, there was no differences due to method of land preparation, possibly due to the long time from imposition of the treatment (two years). For the SB method, in terms of height and stem base, the trees of better performance were *Schyzolobium amazonicum* with 285 $\pm$ 41 cm and 5 $\pm$ 1 cm, and *Tectona grandis* with 194 $\pm$ 25 cm and 5 $\pm$ 0.3 cm, respectively. For the STm method, these values were *Schyzolobium amazonicum* with 262 $\pm$ 39 cm and 4 $\pm$ 0.7 cm, and *Tectona grandis* with 198 $\pm$ 24 cm and 5 $\pm$ 0.5 cm, respectively. As the trial goes on, it is intended to measured the effect of tree over the pasture, the soil, and the animal comfort.

Keywords: Amazon, height, slash-and-burn, slash-and-trituration, stem base, sylvopastoral system, trees

Contact Address: Célia Maria Braga Sarmento, Rural Federal University of Amazon, Belem, Brazil, e-mail: celia_braga05@yahoo.com.br

Hurricane Wilma: When Lianas Protect Trees

EDGARDO I. GARRIDO-PEREZ[1], GERHARD GEROLD[1], MARIO UCAN-MAY[2]
[1]*Institute of Geography, Goettingen University, Landscape Ecology, Germany*
[2]*Independent Contractor, Ejido Solferino, Quintana Roo, Mexico*

It has been proposed that global change increases hurricane's frequency and liana abundance; and that lianas pull and break trees. Indeed, trees hosting live lianas should have a higher probability to be broken during hurricanes. We tested this when Hurricane Wilma stroke North Eastern Yucatan Peninsula (October 2005). There we have 6 pairs of 400m^2 forest plots. We marked and identified all trees $\geq$3,16 cm dbh and lianas $\geq$1 cm diameter at ground level. Before the hurricane we cut the lianas in one plot of each pair. We located: three, two and one pair of plots in the $\geq$55yr, 18yr, and 10yr-old stands respectively. For the $\geq$55yr-old stands, the % of snapped-trunk trees was smaller in the liana-cut (4 %, SD=0,21), than in uncut plots (7 %, SD=2,17), suggesting that lianas "helped" the hurricane to snap trees. For the 18yr-old stand, the hurricane snapped more trunks in the liana-cut plots (averages: liana-cut=8%; liana-uncut=1,3 % snapped trees), suggesting that lianas avoided tree-snapping. The same occurred in the 10yr-old stand (liana-cut=9%; liana-uncut=2,7 % snapped-trees). Liana-cutting did not change the % of other damage types. For example, in the $\geq$55yr-old stands, the % of trees having only large branches remaining were: Liana-cut=0,8 % (SD=1,3), and liana-uncut= 1,3 % (SD=2,2). Dominant lianas were: *Cydista spp* and *Arrabidaea spp* (both soft-bodied Bignoniaceae, in the $\geq$55yr-old stands), and *Dalbergia glabra* (heavy-bodied Papilionoidae, in both, 18- and 10yr-old stands). We suggest *D. glabra* individuals functioned as "fixing-cables" avoiding snapping. Results suggest that liana-cutting before logging may be not-necessary and can be structurally detrimental in secondary forests in hurricane areas.

Keywords: Hurricanes, Liana-cut, Mexico, tree-snapping

Contact Address: Edgardo I. Garrido-Perez, Institute of Geography, Goettingen University, Landscape Ecology, Goldschmidtstr.5, 37077 Goettingen, Germany, e-mail: egarrid@gwdg.de

An Analysis of Spatial Forest Structure Using Neighbourhood-based Variables

OSCAR ALBERTO AGUIRRE CALDERON[1], JAVIER JIMENEZ PEREZ[1], JOSÉ JAVIER CORRAL RIVAS[2]

[1]*University of Nuevo Leon, Departament of Silviculture, Mexico*

[2]*Georg-August-University Göttingen, Institute of Forest Management, Germany*

The study presents an analysis of forest spatial structure and diversity in the Federal State of Durango where the majority of the forests consist of pure pine stands or pine mixed with oak. Natural forests of greater diversity and of high ecological significance are found only in a few isolated localities in the Santa Bárbara valley. These forests, with rare conifers including the genera *Picea*, *Abies* and *Pseudotsuga* are found on particular sheltered, humid sites. For one such rare site, a detailed analysis of forest spatial structure was made, based on three one-quarter hectare plots where all the trees and their coordinates had been assessed. The objective of the study was to provide a quantitative description of the spatial structure of the plots, using new parameters of spatial diversity and to present a method for comparative analysis of the three forest sites. The analysis is using a new approach for describing complex forest structures in a straightforward manner. To evaluate the spatial attributes, it is not necessary to measure distances between trees or to establish tree coordinates. The spatial characteristics can be established merely on the basis of evaluating the immediate neighbourhood of a given number of reference trees. The variables describe the distributions of spatial mingling, size differentiation and contagion, which can be easily interpreted allowing a better description and reproduction of the ecosystems, quantitative comparisons between complex forest structures, as well as the development of indicators of sustainability of forest resource management. This research was supported by the Consejo Nacional de Ciencia y Tecnología (CONACyT), Project: 41181-Z, and by the Alexander von Humboldt Foundation.

Keywords: Contagion, diameter differentiation, distribution, forest density, mingling

Contact Address: Oscar Alberto Aguirre Calderon, University of Nuevo Leon, Departament of Silviculture, Carretera Nacional km. 145, 67700 Linares, Mexico, e-mail: oaguirre@fcf.uanl.mx

Tree Crown Structure in a Mixed Coniferous Forest in Mexico

JAVIER JIMENEZ PEREZ, OSCAR ALBERTO AGUIRRE CALDERON, MARCO AURELIO GONZALEZ TAGLE

University of Nuevo Leon, Departament of Silviculture, Mexico

Characterisation of tree crown structure provides critical information to assess a variety of ecological conditions for multiple purposes and applications. For biomass growth, for example, tree crowns have basic physiological functions: assimilation, respiration, and transpiration. How tree crowns spatially interact and grow can bring about a seamless landscape of unique features and microclimatic conditions that are highly relevant to biological diversity, soil processes, productivity, wildlife habitats, ecosystem health and sustainability. Approaches to measuring tree crown structure and variability within multiple diameter distributions are particularly important in uneven-aged, multi-species natural stands. Results of using diameter distributions and various crown index measurements to describe their respective tree crown attributes and properties are presented and discussed. Specific patterns of values of these indices were found which suggest they have potential for use as indicators of crown structure complexity and variability across a wide spectrum of forest conditions and types. In light of these results, we also address the relevance of these results for forest inventory and monitoring programs. This research presents the results of indicators for tree crown structure in a mixed forest in Sierra Madre Oriental, México. Diameter, height, basal area and crown parameters of 504 trees were measured. Several crown indexes (crown width index, crown thickness index, crown spread ratio, crown projection area and crown surface area) were used. The ratio between the crown surface area regarding the surface area of the light crown and the crown projection area differs greatly between the tree species. The conclusion of this research is that mixed forests present a specific structure, in accordance with its stem parameters, diameter distribution, and crown indexes. This study was financially supported by Consejo Nacional de Ciencia y Tecnología and Comisión Nacional Forestal, through the project: “Análisis Estructural de los Ecosistemas de *Pinus cembroides* (Pino Piñonero) y su Aprovechamiento en el Estado de Nuevo León: 14660” and by Universidad Autónoma de Nuevo León.

Keywords: Crown indices, forest structure, Mexico, mixed forests, tree crown

Contact Address: Javier Jimenez Perez, University of Nuevo Leon, Departament of Silviculture, Carretera Nacional Km. 145, 67700 Linares, Mexico, e-mail: jjimenez@fcf.uanl.mx

Structural Development and Woody Species Composition Along a Fire Chronosequence in Mixed Pine-oak Forest of Northeast Mexico

MARCO AURELIO GONZALEZ TAGLE, JAVIER JIMENEZ PEREZ, OSCAR ALBERTO AGUIRRE CALDERON

University of Nuevo Leon, Departament of Silviculture, Mexico

Although forest fires have become a critical question in Mexico following the fire season of 1998, there is little know regarding the effect of the forest fires on forest structure and composition, and dynamics in the mixed pine-oak forest in northern Mexico. Therefore, a chronosequence of sites with increasing time since fire were selected. This approach is very common studying the effects of forest fire on forest structure and succession as it is almost impossible to perform a real time series as one would have to wait for decades to obtain results. The accurate fire history was developed using tree ring analysis and fire scars. Increment cores were taken from *P. teocote* and *P. pseudostrobus*. The objectives of this study were to determinate how fire has shaped forest structure and composition in mixed pine-oak forest and describe trends and stages of structural development. Stand level vegetations characteristics, environmental data (solar radiation, slope, aspect and elevation) were analysed along a 134 year chronosequence at 23 sites in the mixed forest of the Sierra Madre Oriental. Detrended canonical analysis confirmed that the time since fire was correlated to most biotic variables and indicates that the disturbance regime is tightly coupled to ecosystem function. The study revealed that there were important differences between post-fire cohorts in terms of species richness, stand compositions and structure. High woody plant diversity was generally found in young stands, while the intermediate and major stands showed the lowest woody plant diversity. In old stands, woody plant diversity was increased again. In turn, the forest structure was less divers in young stands compared to intermediate, major and old stands. By exploring forest stand structure and composition in the context of ecosystem function we have addressed for the mixed pine-oak forests an overlooked topic in fire ecology science today. Finally, management of this mixed pine-oak forest should include some component of the natural disturbance regime to maintain forest health and a sustainable use of resources.

Keywords: Chronosequence, fire ecology, forest structure, Mexico, Sierra Madre Oriental, structural development

Contact Address: Marco Aurelio Gonzalez Tagle, University of Nuevo Leon, Departament of Silviculture, Apartado Postal #1, 67755 Linares, Mexico, e-mail: marco.gonzalez@web.de

Effects of Three Different Logging Regimes on the Stand Structure of *Isoberlinia doka* (Caesalpinaceae) and Local Forestry Income in Central Benin (West Africa)

BETTINA ORTHMANN[1], JOCHEN SCHÖNGART[2], KLAUS HENNENBERG[1], STEFAN POREMBSKI[1]

[1]*University of Rostock, Institute of Biosciences, Germany*

[2]*Max-Plank-Institute for Limnology, Plön, Tropical Ecology,*

Selective logging is the most frequent form of timber wood exploitation in the woodland-savannah mosaic in central Benin. The intensity of the selective logging activities has increased considerably in recent years though knowledge of the impact of selective logging on the woodland-savannah mosaic is sparse. In the presented study a modelling approach was chosen in order to test for effects of three different logging regimes on stand structure and local forestry income of *Isoberlinia doka* (Caesalpiniaceae) and local forestry income. The model was applied for woodlands with a high density of *I. doka* that are characteristic elements throughout the Guinea and Sudanian domain in West Africa The three logging regimes correspond to three scenarios developed in the IMPETUS-project (Integrated Approach for Efficient and Sustainable Use of Fresh Water in West Africa). The three scenarios reflect (A) economic growth and implementation of the decentralisation, (B) "business as usual", and (C) economic stagnation and institutional uncertainty. For scenario A the stand structure developed towards a higher number of fertile individuals of *I. doka*. In scenario B stand structure stayed stable but showed a low number of fertile individuals of *I. doka*. Scenario C revealed the absence of fertile individuals and a strong decrease even for *I. doka* individuals of of medium size. Total local forestry income within the modelling period of 20 years was highest in scenario C (354 USD ha^{-1}) followed by scenario B (230 USD ha^{-1}) and lowest in scenario A (130 USD ha^{-1}). However, in the last year of the modelling period (2025) local forestry income was high for scenario A (16 USD ha^{-1}) and scenario B (15 USD ha^{-1}), but extremely low in scenario C (3 USD ha^{-1}). The study shows that only scenario A represents an economically and ecologically optimised management that guarantees both a long-term economic benefit and a potential for natural regeneration of *I. doka* due to a sufficient number of fertile individuals.

Keywords: Africa, conservation, forest management, forest-savannah mosaic, modelling, tree-ring analysis

Contact Address: Bettina Orthmann, University of Rostock, Institute of Biosciences, Frankensteiner Str. 146, 64297 Darmstadt, Germany, e-mail: bettina.orthmann@biologie.uni-rostock.de

Groundnut / Cassava / Maize Intercrop Yields Over Three Cycles of a Fallow / Crop Rotation with Planted *Senna spectabilis*, *Flemingia macrophylla* and *Dactyladenia barteri* on Ultisol

STEFAN HAUSER

International Institute of Tropical Agriculture, Humid Forest Eco-regional Center, Cameroon

Three complete cycles of two years fallow followed by slash-and-burn land preparation and one year of groundnut/cassava/maize intercropping were conducted with *Senna spectabilis*, *Flemingia macrophylla* and *Dactyladenia barteri* planted hedgerow fallows versus no-tree control on an Ultisol in southern Cameroon to determine if yields of this most common subsistence field type can be increased.

Groundnut grain yields were unaffected by fallow system in 1998 and 2001 and the sum of the three cropping years. Maize grain yield was unaffected by fallow system in 1998. In 2001 and 2004 maize grain yield was highest in the *S. spectabilis* system. Total maize grain yield across the three cropping years was higher in the *F. macrophylla* and *S. spectabilis* systems than in the *D. barteri* system. Cassava root yields were in all years and the sum of the three years unaffected by fallow system. Cassava root (1998, 2001) and groundnut grain (2001) yields had significant spatial responses to the distance from hedgerows, with yield increases with increasing distance from hedgerows. Annual biomass production of hedgerow prunings during cropping phases ranged from zero (*D. barteri*) to 3.4 Mg ha^{-1} (*S. spectabilis*). During the growth of groundnut and maize, hedgerows produced $<$ 1Mg ha^{-1} in 1998, $<$ 0.6 Mg ha^{-1} in 2001 and $<$ 0.8 Mg ha^{-1} at any individual pruning. Combined relative crop yields over the three cycles were lower in planted fallow than in no-tree control. The N export with groundnut and maize grain and cassava roots, as an indicator of crude protein production was lower in the planted hedgerow fallow systems than in no-tree control. The planted fallow hedgerow system appears unsuitable to improve crop yields because the nutrient supply from prunings is low due to their low biomass production. Yet on short distances, the spatial response of cassava and groundnut indicates competition between hedgerows and crops, which was most pronounced on cassava and groundnut in the *S. spectabilis* system. The crop combination appears incompatible with planted hedgerow trees as benefits realised by the maize were outweighed by losses in groundnut.

Keywords: Cameroon, cassava, *Dactyladenia barteri*, *Flemingia macrophylla*, groundnut, maize, *Senna spectibilis*, subsistence agriculture, Ultisol

Contact Address: Stefan Hauser, International Institute of Tropical Agriculture, Humid Forest Eco-regional Center, Cameroon, e-mail: s.hauser@cgiar.org

Biomass Production, Nutrient Uptake and Partitioning in Planted *Senna spectabilis, Flemingia macrophylla* and *Dactyladenia barteri* Fallow Systems Over Three Fallow/Cropping Cycles on Ultisol

STEFAN HAUSER

International Institute of Tropical Agriculture, Humid Forest Eco-regional Center, Cameroon

Six years after establishment and after 5 consecutive maize / cassava intercrops, an alley cropping (hedgerow intercropping) experiment on Ultisol in southern Cameroon was converted to a two-year fallow, one-year groundnut/maize/cassava intercropping system. Biomass production and nutrient uptake of all components in planted *Senna spectabilis*, *Dactyladenia barteri* and *Flemingia macrophylla* hedgerow fallow were determined after three two-year fallow phases and compared to natural fallow.

Total above-ground biomass dry matter production by the end of each of the three fallow phases was significantly higher in the *S. spectabilis* system than any other system, due to the significantly higher biomass production of the *S. spectabilis*. Total above ground biomass production in the *F. macrophylla* and the *D. barteri* systems was not different from that in natural fallow. The volunteer biomass between hedgerows was only once significantly reduced by *S. spectabilis* during the first fallow phase. The amount of litter did not differ between fallow systems. The biomass of *S. spectabilis*, *F. macrophylla* and *D. barteri* comprised 96, 95 and 65 % wood, respectively. Relative to the total biomass, wood constituted 67 % in *S. spectabilis* and about 20 % in *F. macrophylla* and *D. barteri systems*.

Except for Mg, the *S. spectabilis* system accumulated more nutrients in above ground biomass than any other system. The highest nutrient uptake achieved in the *S. spectabilis* system was 335 kg ha^{-1} N, 331 kg ha^{-1} Ca, 230 kg ha^{-1} K, and 39 kg ha^{-1} P. Relative to the *S. spectabilis* system, nutrient accumulation, except for Mg, was the lowest in the natural fallow control followed by the *F. macrophylla* and the *D. barteri system*. In *F. macrophylla* and *S. spectabilis*, 95 % and 85 % of the nutrients were accumulated in the wood. In *D. barteri* the nutrient distribution between leaves and wood was approximately equal. Export of the hedgerow wood would remove between 9 and 16 % of the nutrients accumulated in the *F. macrophylla* and *D. barteri* systems but between 27 and 53 % in the *S. spectabilis* system.

Keywords: *Dactyladenia barteri*, fallow, *Flemingia macrophylla*, nutrient accumulation, planted fallow, *Senna spectabilis*, Ultisol, wood export

Contact Address: Stefan Hauser, International Institute of Tropical Agriculture, Humid Forest Eco-regional Center, Cameroon, e-mail: s.hauser@cgiar.org

Participatory Domestication of *Prunus caspica* Kov. & Ekin

KOROUS KHOSHBAKHT[1], KARL HAMMER[2]
[1]*University of Shahid Beheshti, ESRI, Department of Ecological Agriculture, Iran*
[2]*University of Kassel, Agro-Biodiversity, Germany*

In contrast to the widely cultivated agricultural and horticultural crops of the world that have been domesticated for millennia, the initiatives to domesticate some of the indigenous fruit trees in different regions are starting now with wild, or virtually wild, gene pools. Hyrcanian forest region is located in southern of the Caspian Sea. Indigenous people living in rural areas depend on the wild fruit trees in their diet. They use them as table fruit, conserve and local food as well as folk medicine. Throughout the area, there are indigenous species that produce locally important fruits and other non-timber forest products that have the potential to be domesticated to provide economic and livelihood benefits to subsistence farmers. Their commercial importance has led farmers to identify some of these indigenous species as candidates for domestication. *Prunus caspica*, which is locally named "toresh hali ترش هلی" is an indigenous fruit tree occurring in the Caspian coast of Iran and Caucasian. Semi-cultivated individual plants for its edible fruits have been planted in home gardens of the area indicating furthering domestication of this species. The fresh fruit with 2–4 cm in diameter is part of the diet of people in the fruiting season. The fruits are eaten raw or used to prepare a local tart candy. It traditionally was prepared by heating of the fruits for a long time, but today because of more demand, small factories for preparation of this have been established. As demand for fruits and other products is increasing, the supply of fruits from forests is threatened by increasing deforestation. This situation is seriously threatening food and germplasm security and calls for urgent action aimed to expand domestication and cultivation of this species. To be successful, tree domestication should provide farmers with both food security and opportunities for cash generation. Participatory domestication allows farmers to be the beneficiaries and guardians of the use of their indigenous knowledge. This approach conforms to the aims of the Convention on Biological Diversity that seeks to protect the rights of local people to their indigenous knowledge and germplasm.

Keywords: Domestication, Hyrcanian forest region , indigenous knowledge, Iran

Contact Address: Korous Khoshbakht, University of Shahid Beheshti, ESRI, Department of Ecological Agriculture, Tehran, Iran, e-mail: kkhoshbakht@yahoo.com

Predicting Canopy Temperature Distribution Within the Canopies of Tropical Fruit Trees Based on Thermographic Measurements

WOLFRAM SPREER[1], CORNELIUS JANTSCHKE[1], PATUMPORN TIYAYON[2], PITTAYA SRUAMSIRI[3], JOACHIM MÜLLER[1]

[1]*University of Hohenheim, Agricultural Engineering, Germany*

[2]*Chiang Mai University, Department of Horticulture, Thailand*

Thermal imaging is a potential tool for estimating plant temperature, which can be used as an indicator of stomatal closure and water deficit stress. For the field use, however, devices are not commonly affordable. In this study, thermal photographs have been used to develop a reference scheme which allows predicting the temperature distribution within the canopy of fruit trees. Based on this, drought stress can be determined by use of common infrared (IR) thermometry.

With mango (*Mangifera indica* L.) and longan (*Dimocarpus longan*, Lour.), two of the most important fruit crops of northern Thailand, commercially produced under irrigation, have been selected. Two field experiments and one greenhouse experiment were surveyed with a thermal camera (Infratec VarioCAM). Different levels of water supply, different canopy shapes and the respective temperature distribution within the canopy were analyzed. A wet cloth and a latex coated leaf served as wet and dry reference, respectively. Thermographic data was evaluated with "Irbis professional 2.2" software. Climate data (air temperature, wind speed, relative humidity and global radiation) were recorded in the same intervals as thermal photographs were taken. Light penetration through the canopy was taken as a measure for the leaf area. Leaf transpiration was measured by use of a porometer for leaves exposed to sunlight and in the shade.

It was shown that leaves at the outer area of the canopy have a stronger cooling effect by transpiration, which maintains the temperature at a rather constant level, while inner leaves and not transpiring plant parts heat up in the curse of the day. Gradients were worked out for different shapes of canopy, in order to predict the spatial temperature distribution within the three dimensional body of the canopy. Predicted values are being compared to field measurements with IR thermometry.

Keywords: Canopy shape, infrared thermometry, longan, mango, stomatal resistance, water supply

Contact Address: Wolfram Spreer, University of Hohenheim, Agricultural Engineering, 70593 Stuttgart, Germany, e-mail: Wolfram.Spreer@gmx.net

Water Management and Hydrology

Do Farmers Manage their Irrigation System after Transfer of Responsibilities? lessons from Uzbek Water Users Associations.

DARYA ZAVGORODNYAYA

University of Osnabrück, Germany

The process of irrigation water reforms on farmers' behaviour in Uzbekistan is analysed. The research question addressed the design, implementation and further activities of water users associations (WUA) as the water supply organisation connecting governmental and farmers' responsibilities.

Qualitative data was collected by semi-structured interviews, primary observations, participatory rural approach and standardised questionnaire while focusing on stakeholders' perception towards WUAs. Stakeholders consisted of local officials, scientists, local and international experts and members of WUAs. Special attention was placed on the functioning of WUAs' during 2003 to 2005. By 2004 the average irrigated area of the WUAs in Khorezm was 2 400 ha, and the average number of WUA members was 143 irrigators. The range of the irrigated land of WUAs in Khorezm varies from 1 232 ha (in Pitnayk) to 4 096 ha (in Gurlen). The minimum number of WUA members (45 farmers) was observed in Pitnayk, the maximum in Shavat, where one WUA includes 240 farmers.

The results showed that the functioning of a WUA depended on a score of manageral topics, qualifications which lacked WUA's, farmers' and state's sides all together. WUAs have been created by a strong top-down approach causing weak decision-making and low acceptance from members. Members suffered from a lack of information about the purposes and roles of WUAs. The state did not liberalise prices on agricultural commodities . The result showed furthermore that farmers followed own rules of (non-)coping with the newly established WUAs, such as a developed social networking between members of a WUA. This was rooted in the historical, traditional and post-soviet experience of irrigation systems management. The lack of possibilities to determine the type and amount of their production or to sell agricultural products on markets of their choice, does obstruct a smooth and rapid adaptation of farmers to a WUA imposed by the administration.

Keywords: Participatory management, transition

Contact Address: Darya Zavgorodnyaya, University of Osnabrück, Am Hardtbach 35, Alfter, Germany, e-mail: daryaz@web.de

Water Governance Reforms in the Kyrgyz Republic

ELKE HERRFAHRDT

German Development Institute, Department IV: Natural Resource Management and Environmental Policy, Germany

Water scarcity is a problem facing all Central Asian republics, which are highly dependent on irrigation agriculture. It is calling for solutions in the form of changing old and developing new institutions at the international, national and local levels. This paper focuses on reforms and institutional changes in the Kyrgyz water governance. It is based on empirical data generated with the help of a country working group of the DIE postgraduate training course. The Kyrgyz agricultural sector is the most advanced among the Central Asian countries with regard to the implementation of Integrated Water Resources Management (IWRM). Despite the fact that IWRM is underlying many donor programmes in Kyrgyzstan and most reforms in the region, I argue that achievements are far from satisfactory. Preliminary results of the reform process suggest partial or no implementation. Regarding decentralisation progress has formally been made but the newly built organizations (e.g. Water User Associations) are still dominated by old organizations such as the Departments of Water Management (DWM). Old (informal) institutional and mental patterns also prevent progress with respect to participation. Moreover, many relevant policymakers and stakeholders are not aware of the IWRM concept. Accordingly, decentralisation and participation are underdeveloped. This means that Central Asian governments, donor organisations and researchers need to put more emphasis on the fields of sustainable institution and capacity building as well as on the distribution of information among all stakeholders. For only when water management problems at the local and national levels are solved can there be scope for achieving international solutions.

Keywords: Agriculture, Integrated Water Resource Management, irrigation, IWRM, Kyrgyz Republic, water governance, water management

Contact Address: Elke Herrfahrdt, German Development Institute, Department IV: Natural Resource Management and Environmental Policy, Tulpenfeld 4, 53113 Bonn, Germany, e-mail: elke.herrfahrdt@die-gdi.de

Integrated Water Management Options Towards Improving Water Use Efficiency: the Case of a Sub-unit of the Khorezm Irrigation and Drainage System in Uzbekistan

BERNHARD TISCHBEIN[1], CHRISTOPHER CONRAD[2], GAVHAR PALUASHEVA[1], IRINA FORKUTSA[1], MIRZAKHAYOT IBRAKHIMOV[1], JOHN LAMERS[1], CHRISTOPHER MARTIUS[1], PAUL L. G. VLEK[1]

[1]*University of Bonn, Center for Development Research (ZEF), Germany*

[2]*University of Wuerzburg, Geography/Remote Sensing, Germany*

The performance of many irrigation systems in arid and semi-arid regions is far below expectations, which is indicated by high water input, insufficient yields (as a consequence: low water use efficiency) and severe impacts on the water and soil resources. The required increase of food production in the coming decades needs to be realised to a large degree on irrigated lands under the existing restrictions of water availabilty ('more crop per drop') and given an increased competition. At the same time, it is feared, that water availability is becoming even more problematic due to global change. All this leads to a strong need to improve the water use efficiency while taking the requirements of further water users and environmental aspects into consideration.

The Khorezm irrigation and drainage system in the lower Amu Darya basin is a typical example with a very drastic dimension of the current problems. In the context of the ZEF/UNESCO-Project aiming at the restructuring of land and water use towards a sustainable and economically feasible situation, the current irrigation and leaching strategies on field level and medium-size areas have been analyzed. Approaches to raise water use efficiency must start from the field level and consider concurrently the system operation by e.g. irrigation scheduling models. To reduce the root zone salinisation caused by shallow groundwater, to increase the effectiveness of leaching, and to evaluate the option of conjunctive use, the drainage system (operation and design) was considered to develop an integrated water management approach.

Based on a monitoring programme and model simulations, irrigation efficiencies are estimated (in the range of 30 %) and steps (regarding the full range of operation, maintenance and re-design) towards the improvement of water use efficiency are conceived. Although the concepts are related to a special site, the approach can be seen as a promising contribution regarding the situation of many irrigation and drainage systems in arid and semi-arid regions.

Keywords: Drainage, integrated water management, irrigation, Uzbekistan, water use efficiency

Contact Address: Bernhard Tischbein, University of Bonn, Center for Development Research (ZEF), Walter-Flex-Strasse 3, 53113 Bonn, Germany, e-mail: tischbein@uni-bonn.de

Estimation of Potential Recharge and Groundwater Resources - A Case Study in Low Barid Area, Bangladesh

MOHAMMAD AZIZUR RAHMAN, JACKSON ROEHRIG, LIJALEM ZERAY
University of Applied Sciences Cologne, Institute for Technology in the Tropics, Germany

The study area consists of eight upazillas of north-west region of Bangladesh. This is one of the driest part of Bangladesh, normally less rain from November to April. The study area has been irrigated using about 2000 Deep Tubewells. It covers only 80 % of the total cultivable area. The remaining 20 % area is planned to cover by installation of additional Deep Tubewell under Bangladesh Multipurpose Development Authority (BMDA). To ensure long term sustainability the consequences of the groundwater development in the region need to be analyzed. This study tried to explore the appropriate modelling technique to increase agricultural production through optimal utilisation of available water resources using MODFLOW. From the study it can be seen that groundwater resources are inadequate in Raninagar, Durgapur and Puthia upazillas of the study area. Present withdrawals of groundwater to fulfil the requirement of Boro in excess of potential recharges and available resources have created the tendency of continuous lowering of groundwater level in these 3 Upazillas. The deficit indicates a non-sustainable situation with increasing draw down. 80 % coverage of Boro for all cultivable land of Upazillas will incur an additional draw down, for which, quite a large number of shallow Tubewell need to be replaced by Deep Tubewell. Monitoring of groundwater level in these Upazillas need to be carefully continued for future action. Vertical percolation of rainwater is the main source of groundwater; increasing duration of percolation time and area by construction of water control structures on the rivers and Kharies will increase groundwater recharge. There is a possibility of increase of groundwater recharge by conservation of surface water in rivers and kharies in the post monsoon by retention structures. Conjunctive use of surface water —groundwater irrigation should be promoted and a conjunctive water allocation plan must be established.

Keywords: Bangladesh, Groundwater, irrigation , Low Barind, Modflow, Recharge potential

Contact Address: Mohammad Azizur Rahman, University of Applied Sciences Cologne, Institute for Technology in the Tropics, Wetzlarer Strasse.18 Zimmer-11, 51105 Koeln, Germany, e-mail: azizur1978@yahoo.com

Hydrological and Suspended Sediment Concentration Study in a Small Rainforest Catchment (a Case Study in Nopu Catchment in Central Sulawesi, Indonesia)

SANCE LIPU, GERHARD GEROLD
Georg-August-Universität Göttingen, Department of Landscape Ecology, Germany

Hydrological and SSC characteristic in the Nopu catchment is strongly related to the land use changing, topographical condition and the rainfall intensity. Forest conversion and land clearing, leads to higher overall runoff and SSC particularly during the rain events.
The aims of the study are to foresee the effect of land use changing on the hydrological pattern, to investigate the suspended sediment concentration and total output in temporal and spatial basis.
Three weirs have been constructed at the outlet of each river-section but we focus only at weir 2 and 3 represent the slash and burn and natural rainforest sub-catchment. In order to understand good relation between land-use changing, hydrological processes and suspended load, a number of hydrometric sensors were installed. The data were used in this study are water level, turbidity in relation to the discharge and total suspended sediment in respective time. Moreover, the suspended sediment samples were taken automatically at weir 2.
Higher SSC exist in weir 2 by 1.4 to 1.5 times higher than at weir 3. The total annual runoff in weir 2 and 3 at year 2002 and 2004 shows, despite lower rainfall amount in 2004, there was an increasing in runoff of about 219 mm at weir 2.
Soil compaction processes, fast growing of *imperata* and young secondary forest in the study area results on higher runoff but lower SSC in comparison at weir 2 and 3 in year 2002 and 2004. The highest discharge at weir 2 was 1.821 m^3sec^{-1} (with h = 0.529 m) with the highest turbidity of 962 NTU, whereas at weir 3, the highest discharge was 0.440 m^3sec^{-1} (h = 0.384 m) with the turbidity value of 515.5 NTU.
TSS at weir 2 was $\pm$ 186.5 ton (1.61 tha^{-1}) whilst at weir 3 was $\pm$ 3.54 ton (0.043 tha^{-1}). In 2002, higher output due to the higher overall rainfall intensity and the ratio between the SSC output at weir 2 in 2002 was $\pm$ 13-folds higher than one at weir 3 and in 2004 the ratio was jump to 37 times

Keywords: Rainforest catchment, runoff, suspended sediment concentration [SSC], total suspended solid [TSS], turbidity

Contact Address: Sance Lipu, Georg-August-Universität Göttingen, Department of Landscape Ecology, Goldschmidt Straße 5, 37077 Göttingen, Germany, e-mail: sancelipu@yahoo.com

Groundwater Potential Evaluation in the Kompienga Dam Basin by Chloride Mass Balance Approach

JEAN-PIERRE SANDWIDI[1], JANOS BOGARDI[2], PAUL L. G. VLEK[1], NICK VAN DE GIESEN[3], CHARLES RODGERS[1]

[1]*University of Bonn, Centre for Development Research (ZEF), Germany*

[2]*United Nations University for Education and Human Security (UNU-EHS), Germany*

[3]*TUDelft, Delft, The Netherlands*

Water scarcity constrains socio-economic development in the sahelian country of Burkina Faso. During dry periods, residents have utilised groundwater to secure access to drinking water. Groundwater is accessed via hand-dug wells and, since the 1970's, first via modern wells and later on boreholes equipped with manual pumps provided by governmental and non-governmental organisations. Insufficient knowledge of groundwater resources has led to low success rates in exploitation, however, and groundwater resource evaluation appears to be a prerequisite for sustainable water management. This article presents an evaluation of groundwater potential within a watershed of 5900 ha in Eastern Burkina Faso. The results are derived from 18 months of field work in which water was sampled monthly during the rainy season from rain gauges, piezometers and boreholes with hand pump. Deep groundwater from boreholes was also collected during dry season. More than 100 samples were collected from 4 characteristic sites in the research watershed and sent for laboratory analysis for chloride ion concentration.

The climatic water balance was determined based on careful field measurements. Stream discharges were measured using divers, precipitation and other climatic data were collected from rain gauges and weather station. In addition, Eddy Correlation (EC) data were used to infer evapotranspiration.

These data have supported an estimate of groundwater potential using chloride mass balance approach, which has been supplemented and validated using the equations of water balance method. The groundwater potential which reflects the annual recharge estimates will assist in efforts to provide sustainable and reliable water supplies within the basin and the country.

Keywords: Chloride mass balance, groundwater potential, water balance

Contact Address: Jean-Pierre Sandwidi, University of Bonn, Centre for Development Research (ZEF), Walter-Flex-Str.3, 53113 Bonn, Germany, e-mail: wsandjp@yahoo.fr

Climate Change Impact on Lake Ziway Watershed's Water Availability, Ethiopia

LIJALEM ZERAY[1], JACKSON ROEHRIG[1], DILNESAW ALAMIREW CHEKOL[2]
[1]*University of Applied Sciences Cologne, Institute of Technology in the Tropics, Germany*
[2]*University of Bonn, Center of Development Research, Germany*

Lake Ziway, an Ethiopian Rift Valley Lake, is located about 160kms south of the capital city, Addis Ababa, between 7°51'N to 8°7'N and 38°43'E to 38°57'E. It has an open water area of 434km^2 and average depth of 4 m. The area is characterised by semi-arid to sub-humid climate with mean annual precipitation and temperature of 650mm and 25°C, respectively. The lake watershed, which covers an area of about 7300km^2, is composed of two main rivers flowing in to the lake, Meki and Katar, and one river flowing out of the lake, Bulbula. To estimate the level of impact of climate change on the watershed's water availability, climate change scenarios were developed for four future periods of 25 years until the year 2099 using the outputs of HadCM3 coupled atmosphere-ocean GCM model. These outputs were downscaled to the watershed scale through the application of the SDSM model. Generally, both precipitation and temperature show an increasing trend from the 1981–2000 (base period) level. It is estimated that the average monthly and annual precipitation in the watershed might increase by up to 29 % and 9.4 %, respectively. Besides, the average maximum temperature might rise up to 3.6°C, and 1.95°C; and the average minimum temperature 4.2°C and 2°C monthly and annually, respectively. These changes of the climate variables were applied to SWAT hydrological model to simulate future flows. The simulation result reveals that, except during the 2001–2025 period, the total average annual inflow volume into Lake Ziway might decline significantly by up to 19.47 % for A2a- and 27.43 % for B2a-scenarios. This combined with the unbalanced supply-demand equation in the watershed is expected to have significant impact on the lake water balance. This could even worsen the recent lake level fluctuation and aerial coverage contraction. Hence, in Lake Ziway Watershed, runoff is likely to decrease in the future and be insufficient to meet future demands for water of the ever increasing population in the region.

Keywords: A2a, B2a, Ethiopia, GCM, HadCM3, Lake Ziway, Rift Valley, Scenario, SDSM, SWAT, Water balance, Watershed

Contact Address: Lijalem Zeray, University of Applied Sciences Cologne, Institute of Technology in the Tropics, Hahnenstr. 21b-003, 50354 Hürth, Efferen, Germany, e-mail: lijalemz@yahoo.com

Water Consumption in Private Households in Benin

MARION SCHOPP

University of Bonn, Institute of Agriculture Policy, Market Research and Economics, Germany

Benin, a small country in West-Africa, doesn't fall in the category of water scarcity. There are villages with lots of wells or pumps, but there are many cases in which the conditions are not ideal. In the case of the dry season the wells may fall dry, which cause longer ways than during the rainy season. Compared to water consumption in urban areas many of the households have the possibility of getting access to water pipes. But often the standpipes have to be considered as a status symbol. Even if the households are equipped with water pipes, they are not used in several regions. Based on this background information an analysis of water consumption in different areas was made in the framework of an interdisciplinary study (Hadjer, Klein, Schopp, 2005) by the IMPETUS project.

Two hypotheses have to be proved:

1. Water consumption is a linear function to the household size.
2. There is a correlation between main age of the household members and the water consumption.

Regarding important criteria like economic status (rich or poor), demographic status (monogamy or polygamy), water access (kind of sources in villages, peripheries and towns) and seasonality (rainy and dry season as well as short-term strategy of the household members) some correlations could be found:

If the raw data were classified, water consumption from nearly 19 litres could be considered. As expected furthermore the consumption of rich households was much higher than of the poor ones. However, the water consumption seems to be higher in the rainy season than in the dry season even though their domestic need is much increased in the dry season.

These results indicate that water consumption was influenced by a lot of various factors. Programmes aiming for improving the current water situation in Benin need to consider carefully the specific socio demographic and socio economic conditions as well as the preferred taste of different water sources.

Keywords: Benin, household, water consumption, water consumption per capita, water scarcity

Contact Address: Marion Schopp, University of Bonn, Institute of Agriculture Policy, Market Research and Economics, Nussallee 21, Bonn, Germany, e-mail: schopp@agp.uni-bonn.de

Participatory Irrigation Management through Moral Suasion: A Case Study Comparing the Formal and Informal Organisational Structures

KRISHNA REDDY KAKUMANU[1], SIEGFRIED BAUER[1], T. S. AMJATH BABU[2]

[1] *Justus-Liebig-Universität Giessen, Institute of Agriculture and Food Systems Management, Germany*

[2] *Justus Liebig University, Institute of Agricultural Policy and Market Research, Germany*

The decreasing trend observed in the area irrigated by traditional water harvesting structures, mainly irrigation tanks in the last four decades is quite opposite to the trend shown by the area under bore well irrigation, which is expanding radically and is comparable with area covered under major and medium irrigation projects. This shift in usage pattern of irrigation water is mainly attributed to the state interference in operation and maintenance of traditional irrigation structures and the biased provision of the share of the state irrigation budget to major and medium projects. The development of new technologies for groundwater pumping added woes to it. Recently some state governments of India are implementing the policy of free electricity for agricultural purposes to retain their vote bank in rural areas where majority of voters are farmers. This in turn causes an decrease in stabilisation value leading to over exploitation of groundwater resource. In such situations managing the common property resources like irrigation tanks is a difficult task exacerbated with the present political oriented Water Users Associations (WUAs) structure. So under these present circumstances, the current study attempts to find a solution by employing moral suasion (creating awareness, training, educating and voluntary compliance) which can be an effective alternative approach to combat this problem and to encourage the farmers to operate and maintain common property resources. As a part of this a case study was carried out in Nalgonda district of Andhra Pradesh, India for comparing the modus operandi of formal and informal WUAs, which is a part of Participatory Irrigation Management (PIM). The results show that the area commanded by tank irrigation has substantially increased under the informal WUA due to rehabilitation of their irrigation tanks and developing them into a cascade. This in turn had an influence on yield of groundwater pumps in the area as well. The formal one is unable to manage this for long term due to lack of funds and burocratic supervision of Irrigation department. This paper also suggests a modified structure of WUAs for better managerial efforts.

Keywords: Irrigation tanks, moral suasion, stabilisation value, water users association

Contact Address: Krishna Reddy Kakumanu, Justus-Liebig-Universität Giessen, Institute of Agriculture and Food Systems Management, Senckenbergstr.3, 35390 Gießen, Germany, e-mail: kittu_kakumanu@rediffmail.com

Assessment of Perceptions and Attitudes Changes of the Post-tsunami Community on the Use of Aquatic Resources in Ranong Province, Thailand

HEP SOKHANNARO

Royal University of Agriculture, Faculty of Fishery and Aquaculture, Cambodia

Fisheries is an important issue because of severely declining stocks driven by world market demands. While worries about unlimited extraction of resources have lead to a number of measures being tested, most attempts have been unsuccessful. The December 2004 Tsunami affected coastal people severely. However, it may provides us a small window of opportunity to divert attention from going back to fishing if the fisheries are provided with alternative livelihood options. The objective of this study was to understand whether and how the perceptions and attitudes toward fishing in coastal areas may have changed since the tsunami. Five coastal villages in Ranong Province, Thailand were selected because most of impacted people are fishermen or coastal aquatic resources users. A combination of research tools was applied including RRA, field observation, a semi-structured questionnaire and key informant interviews; all applied to measure perceptions and attitudes of the local community. A total of 247 households were contacted, with 494 responses. The analyses indicate that, the recently Tsunami disaster did not influence changes of community's perceptions and attitudes, in particular elder fishermen, in terms of going back to fishing. It was also noted that the majority of fishermen still highly satisfied with their occupation in the hope that fishery resources still available for them. The satisfactions were confirmed with the indicators that fishermen would reinvest in fishing once they have opportunity even their love one or they were severely injured, their fishing facilities were totally destroyed, and their properties were completely damaged by the disaster. The important reasons for not adopting an alternative occupation for these fisher folks relate to fishing as their main source of income, their low levels of educations, the high number of years of experience they have in fishing, and their age. It is difficult to convert them to have alternative occupations which are not related to fishery activities. There is a need to provide alternative sources of income, to relieve dependency on coastal resources or it should have some of the same characteristics as those considered desirable in fishing.

Keywords: Aquatic resources, community perception, Post-Tsunami effect

Contact Address: Hep Sokhannaro, Royal University of Agriculture, Faculty of Fishery and Aquaculture, Chamkar Daung Dangkor District, Phnom Penh, Cambodia, e-mail: vathana20@yahoo.com

Dammed-up Problems: Challenges and Difficulties in Smallholder Irrigation Agriculture in Southwestern Burkina Faso

KONRAD VIELHAUER, ALMUT BRUNNER, PAUL L. G. VLEK
University of Bonn, Center for Development Research (ZEF), Germany

The adequate distribution of water over time as well as its efficient use is one of the major challenges for irrigation agriculture in southwestern Burkina Faso. Although an average annual rainfall of about 900 mm would be high enough to assure sufficient yields in agriculture in general and to account for food production for the 13.9 million inhabitants of Burkina Faso in specific, the unevenly distributed rainfall leads to severe water allocation problems during the dry season. Small dams are so far the most commonly used practice to store rainfall water in the rainy season and to enable irrigation agriculture in the dry season. During the last 20 years, the number of reservoirs in Burkina Faso has increased from 186 in 1985 to more than 600 in 2006 and construction of new dams continue to be sponsored by a great number of donors.
The questions to raise in this paper is, in which way these micro dams may be a viable option particularly to small-farmers, given the problems of farmers' capacity to organise themselves effectively in addition to agro-ecological and economic concerns. Therefore, this study exemplifies the ecological and technological potentials and limitations of small dams in southwestern Burkina Faso in order to illustrate their agro-economical constraints and benefits for small-scale irrigation systems. For example, although some small dams were only built recently, erosion and siltation problems are already visible, which is indicated by changes in reservoir morphology. Water discharge measurements show that these changes in sediment budget have a considerable effect on relative evaporation losses in correlation to water volume and water storage capacity.
On the other hand agro-economical potentials and limitations are studied, concerning the spatial and temporal relations between the flooded land surface to the utilised irrigation perimeters and the number of cropping cycles without irrigation to the number of cropping cycles with irrigation, crop profitability, water use efficiency as well as farmers' organisation and management structures.

Keywords: Crop profitability, erosion, farmers' organisation , irrigation agriculture, off-season crop, rice, silting, small reservoirs

Contact Address: Konrad Vielhauer, University of Bonn, Center for Development Research (ZEF), Walter-Flex-Straße 3, 53113 Bonn, Germany, e-mail: kvielhau@uni-bonn.de

Water and Waste Management

Hygienic Aspects of Sanitation and Water in the Rural Areas of the Mekong Delta, Vietnam

ANDREA RECHENBURG, SUSANNE HERBST
University of Bonn, Institute for Hygiene and Public Health, Germany

Improvements in the availability and quality of water and sanitation are essential for reducing incidences and subsequently death due to waterborne diseases. Therefore, the Millennium Development Goal No. 7 Target 10 aims at halving the population living without adequate drinking water and sanitation until 2015. The Mekong delta is home of 17.6 million people of whom about 14 million live in rural areas. According to estimations about 10 million people in these still underprivileged rural areas live without adequate sanitation and 9.3 million lack safe drinking water. During the last decades, projects by UNICEF and different NGO´s as Oxfam supported the abstraction of ground water for drinking water purposes in the Mekong delta. In general, groundwater is regarded as hygienically safer than surface water but is sometimes rejected by the population because of its taste and chemical quality.
In the framework of the interdisciplinary project SANSED a study was carried out on the hygienic quality of the different drinking water sources and acceptance of sanitation facilities in rural area of the Mekong Delta, Vietnam.
The VAC model (Vuon=orchard, Ao=fish pond, Chuong=livestock farming) is an established integrated traditional Vietnamese farming system, which practices nutrient recycling. Untreated excreta from animals and humans (night soil) are used as a fertiliser in agriculture or as fodder in aquaculture. So, heavy contamination with fecal pathogens and eggs of parasites occurs in soils, vegetables and fish, but also in surface water which is the main drinking water source.
Implementing sanitation solutions that treat human and animal excreta before recycling them, such as biogas plants, will reduce contamination of the surface water and provide as surplus organic fertilisers and energy for free. Especially, in the Mekong Delta, where nutrient recycling is traditionally practised the introduction of biogas systems would enhance life quality and substantially contribute to public health. A participatory approach and complementing hygiene education of the population addressing drinking water hygiene and sanitation issues is assessed as necessary in order to achieve a sustainable long-term impact of these interventions.

Keywords: Drinking water sources, sanitation , Vietnam

Contact Address: Andrea Rechenburg, University of Bonn, Institute for Hygiene and Public Health, Sigmund-Freud-Str. 25, D-53105 Bonn, Germany, e-mail: andrea.rechenburg@ukb.uni-bonn.de

Wastewater Management and Ecological Sanitation at Can Tho University, Mekong Delta, Vietnam

KLAUS UWE, JOACHIM CLEMENS, UTE ARNOLD

University of Bonn, Institute od Crop Science and Resource Conservation - Plant Nutrition, Germany

With up to 1000 inhabitants per square kilometre (average 226 p.p.km^2), the Mekong Delta is one of the most densely populated areas in Vietnam and in the world. Hygienic non-safe reuse of human excreta from latrines directly above fish-ponds is well known in the south of Vietnam, but forbidden by the government. In urban areas wastewater from toilet flushing is collected separately on household level and treated anaerobic in septic tanks, but neither using the biogas nor the nutrients in the effluent. Due to the fact, that about 80 % of the nutrients in domestic wastewater is from human excrements, this project focus on the reuse of urine and feaces. To collect and treat the excrements, different technologies are tested. One existing dormitory (100 male students) and one part of a new dormitory (80 male students) were equipped with source separation for wastewater disposal. The domestic wastewater is drained in four pipes: brown water (diluted feaces) from separation toilets, yellow water (diluted urine) from separation toilets, yellow water from dry urinals and grey water from hand washing, laundry (by hand) and showering. The brown water fraction will be treated by anaerobic reactor to gain biogas and the solids by vermicomposting before using it in agriculture. Experiments with urine will be conducted on drying, precipitation and stripping to ensure hygienic safe use in agriculture later. Greywater will be treated by aerated membrane to gain experiences on this technology for the reuse of water.

First results will be presented on experiences with collection, composition and treatment of separated wastewater sources as well as on acceptance by the users. Based on this, recommendations will be given on implementation and design of systems for ecological sanitation in the Mekong Delta.

Keywords: Construction, ecological sanitation, greywater, urine, vermicomposting

Contact Address: Joachim Clemens, University of Bonn, Institute of Crop Science and Resource Conservation - Plant Nutrition, Karlrobert-Kreiten-Strasse 13, 53115 Bonn, Germany, e-mail: a.clemens@uni-bonn.de

Evaluation of the Waste Water Treatment Efficiency from Small Scale Biogas Systems in the Mekong-delta

UTE ARNOLD[1], JULIA FUCHS[1], ANDREA RECHENBURG[2], TIEN TRAN KHUU[3], JOACHIM CLEMENS[1]

[1]*Universitäty of Bonn, Institute of Crop Science and Reseource Conservation - Plant Nutrition, Germany*

[2]*University of Bonn, Institute for Hygiene and Public Health, Germany*

[3]*Can Tho University, College of Technology, Viet Nam*

In the Mekong Delta waste water of households and farms is mainly discharged directly into the surface waters (fishponds and canals/rivers) which causes hygienic problems and may lead to fish death due to oxygen depletion. One kind of treatment waste water may get at the moment is anaerobic digestion at a few farms owning biogas systems. In this study these different small scale biogas digesters (10 concrete fixed-dome and 9 plastic tube systems, 5,7–8 m^3) were examined and their efficiency to improve water quality was evaluated. Amount and concentration of waste water and hygienic parameters of in- and outflow was analysed (BOD5, COD, N, P, E.coli, pH, EC, Redox, turbidity, suspended solids, Coliforms, Salmonellae, Helminth eggs,) and fluxes calculated. By passing the biogas digester several kg of solids are retained and thus water quality is improved in terms of turbidity but also other water quality parameters. Removal rates were higher in the concrete systems. BOD5 concentrations were reduced to about half of their initial concentrations in average, but reduction rates differed in a wide range between the digesters. *E. coli* and Coliform were reduced by passing the biogas digester, the highest reductions being 3 log units (99.9 %), resulting in *E. coli* concentrations from 9.0E+04 to 1.4E+08 MPN/100ml.

Waste water treated by anaerobic treatment in small scale systems does not match Vietnamese Water Quality standards (TCVN) but can be recommended as a suitable pretreatment, providing advantages compared to other pretreatments like septic tanks or settling ponds.

Keywords: Biogas, hygiene, Vietnam, waste water

Contact Address: Ute Arnold, Universitäty of Bonn, Institute of Crop Science and Reseource Conservation - Plant Nutrition, Karlrobert-Kreiten-Str. 13, 53113 Bonn, Germany, e-mail: uarnold@uni-bonn.de

Evaluation of Small Scale Biogas Systems in the Mekong-delta

JULIA FUCHS[1], UTE ARNOLD[1], TIEN TRAN KHUU[2], JOACHIM CLEMENS[1]

[1]*University of Bonn, Institute of Crop Science and Resource Conservation - Plant Nutrition, Germany*

[2]*Can Tho University, College of Technology, Viet Nam*

Small Scale Biogas Systems are used to produce biogas in the south of Vietnam. The biogas is used as renewable energy for cooking. In this study nineteen biogas systems (9 fix dome systems and 10 plastic tube systems) were surveyed to investigate their operation and to deduce optimisation measures. The biogas amount and quality and the substrate input were analysed. Data on size of the animal house, number of animals and the farmer's experiences concerning maintenance and operation of the systems were collected. All systems were operated by pig excrements. The size of the systems varied between 5,7 and 8 m^3. The size was not adapted to the amount of excrements that was treated in the fermenter: the organic load was in a range of 2,33 and 23,06 kg oDM/d with hydraulic residence times (HRT) between 1,19 and 20,4 days. Biogas was produced between 0,12 and 7,14 CH_4 m^3/d or 26,8 and 882 CH_4 m^3/oDM. We did not find a significant correlation between HRT, organic load and biogas yield. One reason could be the lack of substrate agitation. Substrate may sediment in the fermenter and contribute for a longer time to the CH_4 production.
Most of the farmers are able to control and maintain the systems. The most frequent problem is that during the cleaning procedure of the animal houses the excrements sometimes stuck in the inflow pipe of the biogas plant. From time to time rodents cause problems at the plastic tube system, due to erode the plastic tubes. All farmers are interested to produce electricity with biogas.
The systems may be optimised by decreasing the water amount, which the farmers use for cleaning. With this measure the hydraulic residence time will get increased and the biogas yield may be higher. Although, the effect of this measure needs further investigations in the future.

Keywords: Biogas, concrete, methane production, organic dry matter, plastic

Contact Address: Julia Fuchs, University of Bonn, Institute of Crop Science and Resource Conservation - Plant Nutrition, Karl-Robert-Kreiten-Str. 13, 53115 Bonn, Germany, e-mail: juliafuchs@web.de

Influence of Enzyme Addition and Substrate Loading on the Efficiency of Biogas Production

SHYAM PARIYAR[1], SEBASTIAN WULF[2]

[1]*University of Bonn, Institute of Crop Science and Resource Conservation (INRES), Department of Plant Nutrition , Secondary Resource Management (REMA), Germany*

[2]*University of Bonn, Institute of Plant Nutrition, Germany*

Biogas from the fermentation of slurry is often used for the local supply of energy in developing countries. Fossil energy sources are substituted and therefore greenhouse gas emissions are reduced. Harvesting residues or energy crops can be added to fermentation in order to increase gas yields but the fermentation process might be limited by the hydrolysis of cellulose and hemicellulose, which is a prerequisite for the production of acetic acid as the substrate of methanogenic bacteria. It is discussed, whether the addition of enzymes to biogas digestors can increase the biogas yield. In our experiment enzymes are tested which can also be produced on local level in developing countries.

12 anaerobic digestors (V=8 l) are continuously fed with different co-substrates (maize silage, rye silage and grass silage). To each of the substrates either active or inactivated enzymes are added with 2 repetitions per treatment. Substrates and enzymes are added daily and fermentation residues are removed. The substrate loading is successively increased in order to determine the effect of substrate availability on the efficiency of enzyme addition. Gas production and gas quality is determined daily and frequently samples are taken for determination of residue parameters (e.g. COD, buffer capacity, VFA).

First results with a loading of 1g ODM l^{-1} d^{-1} indicate an increase of biogas production from maize by enzyme addition. Data to be presented will include higher loading rates, gas production from rye and grass as co-substrates and information on the effect of substrate loading on the stability of the fermentation process.

Keywords: Anaerobic digestion, co-digestion, energy crops, greenhouse gas emissions, slurry

Contact Address: Shyam Pariyar, University of Bonn, Institute of Crop Science and Resource Conservation (INRES), Department of Plant Nutrition , Secondary Resource Management (REMA), Hirschberger Str.58-64, na 53119, Bonn, Germany, e-mail: spariya1@uni-bonn.de

Urine Separation and Urine Treatment to Produce a Mineral Fertiliser

PHONG NGUYEN THANH[1], TUAN LE ANH[1], D. V. NI[1], CARSTEN CUHLS[2], UTE ARNOLD[3], JOACHIM CLEMENS[4]

[1]*University of Can Tho, Viet Nam*

[2]*Gewitra, Germany*

[3]*Universitäty of Bonn, Institute of Crop Science and Reseource Conservation - Plant Nutrition, Germany*

In the Mekong-delta waste water from households is not treated. Especially in rural and peri urban areas it could be possible to establish new waste water treatment systems. One option is to divert urine from the other waste water as urine contains more than 80 % of the N, and more than 50 % of P and K that is excreted by . Treated urine can be used as a source of mineral fertiliser in crop plants. Our research purposes are to recycle nutrients in urine instead of eliminating them and to prove that treated urine is environmentally safe to use. We have installed urine diverting systems in a school to collect the urine. The school is visited by female and male 200 pupils. Urine from male and females are collected in separate tanks. In the tanks (500 liters) concentrated sulfuric acid is used to inactivate pathogens and to adjust a low pH to prevent ammonia losses. During the first 3 months 500 liters of urine was collected. The urine was used to fertilise spinach and tomatoes in initial experiments. This collected volume of urine corresponds to a theoretical value of 0.014 $^{liter}/_{pupil}$*d only. Thus, the system seems not be completely accepted. In a questionnaire that was performed prior of installing the toilets, students and teachers appreciated the toilet construction as the former toilets were in poor condition. The collected urine had N and P concentrations of 26.81 and 1 g/l, respectively. The urine was free of *Salmonella* and *E. coli*. In laboratory experiments acidified and untreated were dried to increase the nutrient concentration per kg urine. The urine was dried at 50oC for 72 hours. After drying, about 40 % were lost in the untreated and 18 % in the acidified urine.
Acidification seems to be efficient to reduce pathogens and volatilisation losses of ammonia. Other acids such as phosphoric acid could be used to increase the nutrient concentration. The results are the base for the a treatment unit of urine that will be collected at a dormitory in the University of Can Tho.

Keywords: Acidification, drying, hygiene, urine, waste water

Contact Address: Joachim Clemens, University of Bonn, Institute of Crop Science and Resource Conservation - Plant Nutrition, Karlrobert-Kreiten-Strasse 13, 53115 Bonn, Germany, e-mail: a.clemens@uni-bonn.de

Valuable Added the Agricultural Waste for Farmers Using in Organic Farming Groups in Phitsanulok, Thailand

UDOMPORN PANGNAKORN

Naresuan University, Department of Agricultural Science„ Thailand

The royal government of Thailand is very active in efforts to educate farmers in good agricultural practices, organic farming, and sustainable agriculture. This includes an active policy on improved livelihood, education of the rural population, and also reduced pressure environment caused by agricultural production. Group of farmers in Phitsanulok province, Thailand, have grown bananas and produced several products from bananas for widely food used, medicinal used, animal feed and other used etc. Banana peels are become serious environmental problem caused by the bananas production. Utilisation of bananas peel for organic fertiliser was studied by Naresuan University, Thailand. Potential of bananas peels to make organic fertiliser and development to commercial were done. Laboratories are in place to test efficiency of the fertiliser was investigated. This project organised several training course for the groups of farmers on "the development of compost manure fertiliser from banana peels". During these courses the farmers learn to make organic fertiliser from the banana peels. Additional, the farmers learn organic farming is a whole-system approach to optimising the natural fertility resources of a farm. It works through traditional practices of recycling farm-produced livestock manures, composting, green manuring, and crop residue management. The training helps the farmers to understand major nutrient content of fertiliser, organic material in their community, soil organisms to break them down to release nutrients, understand how to use technology equipment for commercially and include marketing. The outcome of the project not only reduced cost of using chemical fertiliser but also increased income and strengthening farmers of the organic farming group.

Keywords: Agricultural waste, banana peels, organic farming, organic fertiliser

Contact Address: Udomporn Pangnakorn, Naresuan University, Department of Agricultural Science„ Department of Agricultural Science Faculty of Agriculture Natural Resources and Environment, 65000 Phitsanulok, Thailand, e-mail: udomporn1@yahoo.com.au

Effect of Manure, Inorganic Fertiliser and Manure-fertiliser Combination on N Losses, N-use Efficiency and Yield of Oilseed Rape (*Brassica napus* L.)

HOSSEIN SABAHI[1], AMIR GHALAVAND[2]

[1]*Shahid Beheshti University, Agroecology, Iran*

[2]*Tarbiat Modares University, Agronomy, Iran*

Farmyard manure is a valuable source for plant nutrition, but high N loss and low N fertiliser use efficiency are serious challenges fronting them. In attention to environmental importance of this problem, we suggested this 2-year experiment on winter rapeseed (*Brassica napus* L.) in rainfed condition (average precipitation was 700mm). Treatments conclude 0, 50,100, 150, 200 kg N ha^{-1} urea (fertiliser treatments), 150 kg N ha^{-1} urea + 50 kg N ha^{-1} manure (Int1), 100 kg N ha^{-1} urea + 50 kg N ha^{-1} manure (Int2), 50 kg N ha^{-1} urea + 100 kg N ha^{-1} manure (Int3), 150 kg N ha^{-1} manure (Org). The inorganic fertiliser plots also received 25 kg P ha^{-1} and 50 kg K ha^{-1}. Optimum fertiliser treatment was 150 kg N ha^{-1}. The greatest seed yield (3 t ha^{-1}) obtained in 150 kg N ha^{-1} + 50 kg N ha^{-1} treatment in two year. Seed yield for organic treatment (org) was nonsignificantly lower in 2002 (2.3 vs. 2.5 t ha^{-1}) and significantly greater in 2003 than optimum fertiliser treatment (2.9 vs. 2.6 t ha^{-1}). Results also showed that Int2 and Int3 treatments decrease N loss (4 and 9.5 kg N ha^{-1} yr^{-1} respectively) compared to manure (25.5 kg N ha^{-1} yr^{-1}) and optimum inorganic fertiliser (38.5 kg N ha^{-1} yr^{-1}). Apparent N use efficiency was calculated as [(total treatment N uptake in 2 yr — total check N uptake in 2 yr)/ N applied in 2yr] $*100$. This was 20 % for manure (org), 57 % for Fropt, 37 % for int2 and 24 % for int3. This difference may be due to remained 57 % of N in soil from manure treatment at final of experiment. The greatest physiological N use efficiency (average 26 %) was obtained in Int3 treatment, this can be due to better synchronisation of N release and crop uptake.

Keywords: winter oilseed rape, N loss, N-use efficiency , nitrogen, organic

Contact Address: Hossein Sabahi, Shahid Beheshti University, Agroecology, Evin, Tehran, Iran, e-mail: sabahy_h@yahoo.com

Drought, Irrigation and Water Use

Risk Management in the Rain-fed Farming of Gedaref Area, Eastern Sudan

RAJAA MUSTAFA[1], MAU MARKUS[2], FRIEDRICH KUHLMANN[2]

[1] *University of Gezira, Agricultural Economics, Germany*

[2] *Justus-Liebig-University Giessen, Institute of Agricultural and Food Systems Management, Germany*

It is argued that the adoption of the recommended improved technologies in the mechanised rain-fed sub-sector of Gedaref in Eastern Sudan can increase farm income while diversifying by introducing sheep and gum arabic enterprises to sorghum monoculture of Gedaref may lead to farm income stability. Under these arguments in favour of diversification and use of improved technology, this paper aims mainly at studying, analysing the performance and to evaluate different management strategies in this sub-sector under uncertainty. The mechanised rain-fed agricultural sub-sector of the Sudan has high potentiality of building a national food stock and foreign exchange earnings, which could contribute substantially to agricultural development as well as of the whole economy. However, the agricultural production in this sub-sector is generally characterised by a high degree of instability, which arises from the nature of the agricultural production that dependent on uncontrollable weather conditions and unpredictable input and output prices, which resulted in instable, production, farm income and market risk. The financial feasibility of different investment and management strategies is evaluated under both; the current traditional and the improved cultural practices. The stochastic budgeting technique by using NPV of farm income as a measure of performance is used in this paper to simulate production, market risk and the performance over a twenty-years planning horizon on an average farm in the study area. Empirical results showed that the introduction of forest and livestock activities contribute substantially to farm income stability with very low probability of loss at the end of the planning period while the adoption of the new recommended technology also stabilise farm income and guarantee the profitability of the business at the end of the same planning period.

Keywords: Gedaref, Mechanized, Rain-Fed, risk Management, Stochastic Budgeting

Contact Address: Rajaa Mustafa, University of Gezira, Agricultural Economics, Unterhof 69 App. 1004, 35392 Giessen, Germany, e-mail: mrajaa@yahoo.com

How Do Farmers Source Sorghum Seed after a Poor Rainy Season in Southern Mali?

SONJA SIART[1], EVA WELTZIEN[2], MOUSSA KANOUTÉ[2], VOLKER HOFFMANN[1]

[1]*University of Hohenheim, Department of Agricultural Communication and Extension (430a), Germany*

[2]*International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Mali*

Farmers in Mali normally use home-produced seed for sowing sorghum (*Sorghum bicolor* (L.) Moench). In case of problems, farmers resort to using seed from other sources. To better understand what problems farmers in southern Mali may have with seed availability we conducted a survey during the season 2005/2006, following a drought year.

The survey was conducted immediately after the sowing period of sorghum to be able to explore the actual sources of seeds farmers had used. Individual interviews with 287 household heads in a total of 16 villages in the two project regions were conducted using a questionnaire.

Results show that following the drought year a major percentage of farmers (65.2 %) planted more than one sorghum variety. This is in contrast to results obtained from a similar survey one season earlier, following a good year for sorghum production. Similarly farmers mentioned using other seed sources than their own production more frequently, e.g. the own village (30 %), as well as other villages, projects and markets. Reasons for searching seeds from outside the household were mostly the interest in cultivating a new variety and to some smaller extend the interest in testing a new variety. About 10 % of farmers mentioned that they ran out of seeds. Relations between the seed donors and seed beneficiaries are mostly family ties and neighbourhood. Projects, friends and markets are of smaller importance. Seeds are exchanged or given for free. Purchase is more prominent this season, but still it is less important than the traditional ways of trading seeds.

In the 2005 season the majority (75.5 %) of farmers reported that they extended the surface sown with sorghum and 42.6 % mentioned the food shortages" after the previous season as explanation.

It can thus be concluded, that farmers did not face a problem in seed availability and access after the bad rainy season. Their decisions regarding seed source and variety choice were driven by their concern about the low cereal harvest in the preceding year. This concern was primarily addressed by extending the area planted with sorghum the following season.

Keywords: Mali, seed access, seed availability, seed sources, sorghum

Contact Address: Sonja Siart, University of Hohenheim, Department of Agricultural Communication and Extension (430a), Stuttgart, Germany, e-mail: sonja_siart@web.de

Optimal Cropping Pattern under Conditions of Uncertain Water Supply. A Spatially Explicit Approach for Khorezm Region, Uzbekistan

IHTIYOR BOBOJONOV, MARC MÜLLER, JOHN LAMERS, CHRISTOPHER MARTIUS

University of Bonn, Center for Development Research (ZEF), Germany

Khorezm is an Oblast of Uzbekistan in the lower Amu Darya Basin close to the remainders of the Aral Sea, and therefore strongly affected by the well-known ecological problems, that have their roots predominantly in the national and international water use policies. The latter contribute to elevated water usage and an estimated 16–18,000 m^3 of irrigation water per hectare are used. The high level of irrigation water application causes shallow groundwater tables and secondary soil salinity. Moreover, fluctuations in the regional irrigation water supply from the Amudarya River create severe uncertainty in agricultural production. Therefore, there is an urgent challenge for improving both, the ecological situation and the security of agricultural income, which presently is very low compared to the Uzbek average. Despite various reforms, farmers are still restricted in their decisions what to crop and when. Therefore, the work described in this paper aims at supporting the regional crop allocation and water distribution process with the purpose to improve the ecological and economic situation in the Khorezmian agricultural sector. The model established in this study aims at decision makers on the governmental level as well as at single farmers. $\text{Economic}/_{\text{mathematic}}$ optimisation techniques and GIS tools were combined for a better implementation and integration of spatial data and microeconomic data. An expected value-variance (EV) approach is used to analyse the risk associated with variability and the stochastic nature of water availability. Capillary rise from groundwater, soil salinity, soil texture and soil humus, distance from irrigation canals are the main criteria for defining optimal crop-mixes for certain locations while taking into account the risk associated with the activity type and level of water use. Results show that substantial increase in water efficiency can be achieved by adjusting the production patterns with respect to risk issues, which is essential in improving the ecological and economic situation in the region.

Keywords: Amu Darya Basin, Expected value-variance (EV) analysis, Spatial approach, Uncertainty, Water use effecinecy

Contact Address: Ihtiyor Bobojonov, University of Bonn, Center for Development Research (ZEF), Walter-Flex-Str. 3, 53113 Bonn, Germany, e-mail: ihtiyor@uni-bonn.de

The Effects of Drought Stress on Mexican Pine-oak Forests in the Eastern Sierra Madre

WIBKE HIMMELSBACH, EDUARDO JAVIER TREVIÑO GARZA, HUMBERTO GONZÁLEZ RODRÍGUEZ

University of Nuevo Leon, Department of Silviculture, Mexico

Mexican pine-oak forests are exposed to extreme conditions: high temperatures, scarce precipitation distributed irregularly over the year, and intensive silvo-pastoral activities. This and the irrational and unsustainable use of natural resources is modifying hydrological cycles, ground water supply, and contributes plainly to soil erosion. As an approach to understand how natural tree regeneration copes with these stress factors, the water relations in mixed pine-oak forest were studied in the Eastern Sierra Madre. Water potentials (Ψ) were related to soil water-content and evaporative demand components in natural pine-oak forest where silvo-pastoral influences could be ignored for the moment. In this way, the exclusive effects of climatic and soil variables on the forest species oak, pine, cedar, arbutus, and acacia were investigated at different aspects (north and southeast) from January 2006 until today. Environmental data (air temperature (Temp), relative humidity (RH), vapour pressure deficit (VPD), precipitation, and soil water-content) were taken simultaneously. The water potentials were measured two times a day, 6:00 a. m. and 12:00 p. m. and possibly twice a month. All studied species showed the typical diurnal pattern of variation in Ψ, high values at predawn and low values at midday. Comparing the two aspects, all Ψ, soil water-content, VPD and Temp at midday showed significant differences. In general, the southern site was significantly warmer and dryer, and Ψ were more negative at the southeast. With increasing temperature, the Ψ decreased for all species at both sites, while oaks had the highest values and pine and cedar trees the lowest at the north. At the southern site, acacia had highest Ψ followed by oak, pine, and cedar with more negative values. So, oak was the less stressed species at the north and acacia at the southeast. Pines and cedars seemed to be more stressed at both aspects. The differences between the Ψ measured at both aspects could be explained by the significant difference in soil water-content, VPD and Temp at midday.

Keywords: Climate, drought stress, pine-oak forest, soil water content, water potentials, water relations

Contact Address: Wibke Himmelsbach, University of Nuevo Leon, Department of Silviculture
current address: Mexico, e-mail: waldkauz-ruft@web.de

Interactions Between Nutrient Availability and Soil Moisture in Tropical Calcareous Soils from Yucatan, Mexico

EDITH AGUILA ALCANTARA, HOLM TIESSEN

Georg-August-Universität Göttingen, Institute of Plant Production and Agroecology in the Tropics and Subtropics, Germany

As the strong seasonality in the tropics affects soil moisture, this factor can be an important limiting factor for nutrient availability in calcareous tropical soils. Based on this sentence, we assess in red and black calcareous tropical soils from Yucatan, Mexico; the interaction between two soil moisture levels (100%WHC and 50 % WHC) and the availability to plants of five nutrients (Ca^{2+}, Mg^{2+}, K^{+}, PO_4^{3-}, and NO_3) using ion exchange membranes. Three different land uses were identified: forests, milpas, and homegardens. Because of the extreme soil variability, which appears as a mosaic of black and red soils, the sampling was based on a random design, with colour differentiation. The experiment was conducted during 45 days under controlled laboratory conditions. Soils were placed in two caps with a resin membrane in between and joined with the help of tweezers. Resin membranes were replaced every five days, and the removed membranes were extracted in 0.5 N HCl. Extracts were kept at 4°C, and cations were analysed by atomic absorption Ca^{2+} and Mg^{2+}, and K^{+} by flame emission spectroscopy. Anions were measured by colourimetric analyses. The availability of all nutrients, except phosphorus, was lower at full moisture compare to 50 % WHC in both soil types. For instance, nitrate decreased 40 % when soil water content reached full moisture, while phosphate availability increased around 90 %. Homegardens presented higher content of phosphate and potassium, while nitrate was more available in forests. Related to the differences between both soil types, it was found that nitrate, phosphate and potassium content was lower in red soils compare to the black group, but magnesium was higher. Summarizing, fertility problems of these soils have been caused by low levels of phosphate and potassium, and their interactions with the available water.

Keywords: Calcareous tropical soils, ion exchange membrane, nutrient availability, resin, soil moisture, water content, Yucatan

Contact Address: Edith Aguila Alcantara, University of Göttingen, Crop Sciences - Agronomic in the Tropics, Albrechtthaerweg 20-C, 37075 Göttingen, Germany, e-mail: edithaa72@yahoo.es

Comparing Slash-and-burn and Slash-and-trituration/mulch as Land Preparation for Pasture Establishment in Brazilian Eastern Amazon: Soil Humidity

PAULO CELSO SANTIAGO BITTENCOURT[1], JONAS BASTOS DA VEIGA[2], ARI PINHEIRO CAMARÃO[2], OSVALDO R. KATO[2], BARBARA RISCHKOWSKY[3]

[1]*Rural Federal University of Amazon, Institute of Agricultural Science, Brazil*

[2]*Brazilian Agricultural Research Corporation (EMBRAPA), Brazil*

[3]*Georg-August University of Göttingen, Institute of Agronomy and Animal Production in the Tropics and Subtropics, Germany*

Land preparation is a important factor for land-use sustainability in tropical forest areas. For the last ten years the Embrapa Amazônia Oriental research centre has tested slash-and- tritruration/mulch (STm) of secondary vegetation as a new method of land preparation before planting crops and pastures in Northeastern Pará, Brazil. Besides avoiding the negative impacts of fire of the traditional slash-and-burn (SB), the STm method might also improve soil humidity favouring plant growth. This study compared the impact of both methods of land preparation on the dynamics of soil humidity on a sandy Latossolo Amarelo under pasture use in the municipality of Igarapé-Acu (01° 06' S and 47° 31' W). The predominant climate is hot and rainy, with a dry season from September to December, annual temperature from 25 to 27°C and average annual precipitation of 2,500 mm (Am type of climate). An area of 4.8 ha covered by a 10-year old secondary vegetation (capoeira), with a biomass of 74 t MS ha^{-1} was divided in two similar parts, one was slashed and burnt in December 2000, and the remaining part was cut and mulched with an AHWI bush chopper in February 2001. In March 2001, a *Brachiaria brizantha + B. humidicola* pasture was planted in both area. After the pasture establishment, both areas were grazed by steers in a rotational system (18 days of grazing, 36 days of rest, three paddocks). From September 2003 to June 2004, every 15 days humidity (gravimetric method) was measured in five soil layers, 0–5; 5–10; 10–20; 20–40; 40–60 cm, at two randomly selected points of each paddock. The available forage mass was measured each 36 days. It was observed that, in comparison to SB, the STm method increased soil humidity during the study period, mainly in the upper soil layers (0–5; 5–10; 10–20 cm), corresponding to an increase in forage mass. The results indicate a potential advantage of agricultural practices that avoid the use of fire in land preparation.

Keywords: Amazon, land preparation, mulching, pastures, secondary vegetation, slash-and-burn, slash-and-trituration, soil humidity

Contact Address: Paulo Celso Santiago Bittencourt, Rural Federal University of Amazon, Institute of Agricultural Science, Belém, Brazil, e-mail: paulocelso2006@yahoo.com.br

Moisture Effect on Enzyme Activities in Calcareous Soils from the Yucatan Peninsula, Mexico

ADRIANA CAMPOS[1], BARBARA WICK[2], HOLM TIESSEN[1]

[1]*Georg-August-University Göttingen, Crop Sciences -Agronomy in the Tropics and Subtropics, Germany*

[2]*Humboldt-University Berlin, Division of Soil Science and Site Science, Germany*

The Yucatan Peninsula presents a mosaic of different soils, which is the main cause of their distinguishing chemical characteristics and might originate differences in the mineralisation rate and transformation of nutrients. The principal agricultural practices in the region are the traditional shifting cultivation (Milpa), and Home Gardens. Previous studies showed a decline in soil fertility that may be associated to problems with the sorption of nutrients and organic matter. There is no information about the impact of these agricultural practices on transformation of nutrients, and the possible problems related to moisture content, which plays an important role on the biochemical processes of the soil. Therefore, the study had as objective to evaluate the effect of moisture content on enzymes' activities in the soil. Soil enzymes play an essential role in catalysing reactions necessary for organic matter decomposition and nutrient cycling. Four enzymes were chosen: Acid and Alkaline Phosphatase, β Glucosidase, and Protease. These give indications on the potential capacity of the soil to carry out specific reactions and can have an important implication in nutrient cycling. The study sites were located in the communities of Hocaba and Xmakuil, Yucatan, Mexico. The sampling was done in the dry season (December 2004). Three ecosystems were studied: Milpa, Home Garden (agricultural systems), and Forest (reference system). The soil samples were taken at 0–10 cm depth. To evaluate the effect of moisture on the enzymes' activities, two contrasting moisture contents were employed (50 and 100 % WHC) and Control soils (without water). In general, a decrease in enzyme activity was found in the Milpas and Home Gardens in comparison to the Forest, possibly due to lack of appropriate organic substrate (specially in Home Gardens) and to soil degradation. The moisture content had an effect on the enzymes: the highest moisture content produced a decline between 10–73 % of enzyme activity in comparison to Control soils. At 50 % WHC, there was also a decrease, but the effect was not too pronounced. Protease was the enzyme that reacted most to moisture content.

Keywords: β-Glucosidase, acid and Alkaline Phosphatase, Home Garden, Milpa, Moisture Content, Protease

Contact Address: Adriana Campos, Georg-August-University Göttingen, Crop Sciences -Agronomy in the Tropics and Subtropics, Am Weendespring 24, 37077 Göttingen, Germany, e-mail: adrianajcampos@yahoo.es

Effect of Variable Irrigation on Water Use and Growth of Jutemallow (*Corchorus olitorius*)

AYORINDE OLUFAYO[1], JOHNSON FASINMINRIN[1], AYODELE EBENEZER AJAYI[2]
[1]*Federal University of Technology, Agricultural Engineering, Nigeria*
[2]*University of Bonn, Center for Development Research (ZEF), Germany*

Jute mallow (*C. olitorius*) is a leafy vegetable widely cultivated in sub-saharan Africa and most Asian countries and it is a good alternative for okra and other vegetables. However, its production during off—season will require good knowledge of its behaviour under water stress. Therefore, water use, growth and biomass yield of Jute mallow (*C. olitorius*) under three water management strategies were investigated during the dry season of 1999 and late rainy season of 2000 on the field at the Experimental farm of the Federal University of Technology, Akure, south western Nigeria. The crop was subjected to three irrigation treatments A, B and C, i.e. 1Ep (full pan evaporation), ¾ Ep and ½ Ep respectively (three replication). Soil moisture content in the first 50 cm layer was monitored. Yield and agronomic parameters were measured during crop growth. Plant height in the three treatments A, B and C were 93.9 cm, 80.2 cm and 63.9 cm in 1999 and 102.7 cm, 96.9 cm and 81.0 cm in 2000 respectively. Values of leaf area and leaf area index (LAI) were highest in irrigation treatments at full level (A) during the trials. Biomass yield at crop maturity were 5.22 tha^{-1}, 4.14 tha^{-1} and 1.96 tha^{-1} in 1999 and 6.02tha 1, 5.89 tha^{-1} and 5.76 tha^{-1} in 2000 for A, B and C treatments respectively. A significant decrease in water use efficiency (WUE) for biomass production was observed with decrease irrigation water application. The values of WUE were 0.70Kgm^{-3}, 0.59 Kgm^{-3} and 0.15 Kgm^{-3} of water in 1999 and 0.51 Kgm^{-3}, 0.44Kgm^{-3} and 0.19 Kgm^{-3} in 2000 for irrigation treatments 1 Ep, ¾ Ep and ½ Ep respectively at 7 WAP (weeks after planting). These results suggest that the crop made efficient use of water applied at full level for optimum growth and yield.

Keywords: Biomass yield: Pan evaporation, irrigation, Jute mallow, Leaf Area Index (LAI), Water Use Efficiency (WUE)

Contact Address: Ayorinde Olufayo, Federal University of Technology, Agricultural Engineering, P. M. B. 704, 341000 Akure, Nigeria, e-mail: ayo_olufayo@yahoo.com

Irrigation Systems in Syria: Can Institutional Reforms Control the Degradation?

IBRAHIM ALABDULLAH, ERNST-AUGUST NUPPENAU

Justus- Liebig University Giessen, Institute of Agricultural Policy and Market Research, Germany

In Syria, where the extent of water scarcity is reflected in the staggering figures of water deficit i.e. 258 m^3 per person per year, paradoxically, agriculture accounts for about 95 % of total consumption of water. Driven by this fact, current research work tries to address the major bottlenecks in ensuring efficient use of water in two distinct agricultural entities i.e. the public river (Euphrates) irrigation system and private wells irrigation system. The two major issues that meddle with the economic use of water in the former system are **(1)** the fixed water charge per unit area irrelevant to the consumption level and **(2)** lack of proper monitoring of water use. In private wells region, the main issues are **(1)** uncontrolled water pumping and **(2)** illegal well digging. Even though, water intensive crops, wheat and cotton are predominantly cultivated in the research area, the analysis is limited to cotton alone as it requires more water (9887m^3|ha) compared to wheat (3959 m^3|ha). The objectives of this study are **(i)** comparing costs of existing irrigation technologies and determining the water productivity in cotton fields and **(ii)** finding institutional solutions for the current water problems in both regions. The existing water policy has caused the lowering of groundwater levels in wells region while raising it in river irrigated zones. Most farmers face water crisis in wells irrigated region while spatial location of the farmers determines the degree of water scarcity in the river irrigated system. The central solution can be the pricing policy reforms that link the water charges to level of consumption and seasonal availability. These policy changes are expected to enhance water productivity in cotton irrigated fields by accelerating shifts in technology (e.g. drip irrigation systems) which are capital intensive as well as water management measures which are labour intensive.

Keywords: Irrigation systems, water policy, water problems, water productivity

Contact Address: Ibrahim Alabdullah, Justus- Liebig University Giessen, Institute of Agricultural Policy and Market Research, Senckenbergstr. 3, 35390 Giessen, Germany, e-mail: ibra161@yahoo.de

Effects of Alley-cropping Systems on Crop Productivity and Water Use Efficiency in Semi-desert Region of Northern Sudan

HAIDER SHAPO[1], ADAM ADAM[2]

[1]*Agricultural Research Corporation, Sudan (ARC), Agroforestry Research Unit, Sudan*

[2]*University of Gezira, Faculty of Agricultural Sciences, Sudan*

A series of experiments were conducted in the semi-desert regions of Northern Sudan during 1998–2000, to investigate the potential of alley cropping system for exploiting residual water in the surface horizons and beyond the rooting depth of associated crops. The first experiments were assigned in RCB design, replicated 3-times. Three N-fixing trees were used in the alley cropping hedgerows, namely, *Acacia ampliceps*, *Acacia stenophylla* and *Leucaena leucocephala*. Regular monitoring was carried out for determining water use in the system. In the second experiment, monitoring of *A.stenophylla* alley cropping microclimate was studied, including measurements of solar radiation, wind speed, relative humidity, maximum and minimum temperatures, and shade movement. Changes in the alley cropping microclimate were quantified, and related to plant responses and growth of all components of the system. The obtained results showed that there were complex interactions and extensive overlap between different climatic factors and water use in the system. In the first experiment there were significant differences ($p = 0.01$) among the tree species in their abilities to extract the water from the different soil horizons as the trees differed in their growth nature and competitive interactions. The A.stenophylla tree, with its deep roots and open canopy, gave the highest saving in irrigation water. On monthly basis, the maximum savings occurred during June. In the second experiment, the Carrot yield increased over the control by 487 % and its yield increased as the solar radiation decreased across the different zones of the alley. Similarly, sweet pepper gave a total yield of 5833 $^{kg}/_{ha}$ of fruit fresh weight. High wind speed and solar radiation, which characterised this season tended to cause water stresses for the plants growing in the control.

Keywords: *Acacia stenophylla*, Alley cropping, semi —desert, Solar radiation , Water use

Contact Address: Haider Shapo, Agricultural Research Corporation, Sudan (ARC), Agroforestry Research Unit, Wad Medani, Sudan, e-mail: hsafi123@yahoo.com

Technology, Models and GIS

GIS and Remote Sensing

Global Dataset of Monthly Crop-specific Irrigated Areas around the Year 2000

FELIX PORTMANN, PETRA DÖLL, STEFAN SIEBERT
University of Frankfurt (Main), Institute of Physical Geography, Germany

To assess virtual water trade in a globalised world, we need to differentiate water requirements of rainfed and irrigated agriculture. To achieve this differentiation with a higher reliability than in the study of Yang et al.(2006), it is necessary to know which crops grow where and when under either rainfed or irrigated conditions. Here we present the first version of a global dataset of monthly crop-specific irrigated areas around the year 2000. A twin global dataset of monthly crop-specific rainfed areas which is consistent with the irrigated areas is currently being developed. The dataset considers 26 irrigated crops including all major food crops, permanent cultures, cotton, and irrigated grassland. For each month of the year (representative for the time period 1998 to 2002 around the year 2000) the irrigated area of each crop in each 5 minute grid cell (size 8 km $\times$ 8 km at the equator) is provided. As data sources national cropping calendars (FAO) and mainly national statistics on harvested areas for both irrigated and rainfed crops (FAO, EUROSTAT, and others) were combined with spatially explicit 5 minute grids of areas equipped for irrigation (Siebert et al., 2005) and a global data set of main crop types (Leff et al., 2004). We present the methods for the map generation, selected elements of the resulting ample dataset, and discuss the limitations of the dataset. Global and regional studies can take profit of this dataset. It might be used for a broad range of applications besides the currently foreseen global water balance calculation with WaterGAP (Döll and Siebert, 2002).

Keywords: Global mapping, harvested crop area, irrigation, virtual water, water balance

Contact Address: Felix Portmann, University of Frankfurt (Main), Institute of Physical Geography, Senckenberganlage 36, 60325 Frankfurt am Main, Germany, e-mail: portmann@em.uni-frankfurt.de

Biogeography and GIS: Case Study *Centrosema brasilianum*

SARAH SCHNEIDER[1], RAINER SCHULTZE-KRAFT[1], JOSE FARIÑAS[2]

[1]*University of Hohenheim, Institute for Plant Production and Agroecology in the Tropics and Subtropics, Germany*

[2]*National Institute of Agricultural Research (INIA), CIAE-Monagas, Venezuela*

Plant and animal biodiversity is constantly decreasing as result of demographic pressure and overexploitation of natural resources, and valuable genetic resources are lost. This includes many unexplored and/or insufficiently researched plant species that could be useful for nature and humankind.

Among such species, the wild pasture legume *Centrosema brasilianum* (L.) Benth. is insofar an interesting species as it is well adapted to drought and acid, low-fertility soils. Because of these characteristics, it has a high potential for marginal production conditions where farmers are in particular need of improved livelihoods. Available germplasm collections of *C. brasilianum* have still a narrow genetic base which, for successful germplasm development programs such as breeding projects, should be increased by further collecting. However, the natural distribution of the species is not sufficiently well known to design cost-efficient collection strategies.

In this study, an updated digital map of the geographic distribution of *C. brasilianum* germplasm in tropical America is created with the help of the GIS tool FloraMap™. The species occurs from latitude 10° N (north Venezuela) to 16° S (southwest Brazil) and from longitude 35° W (northeast Brazil) to 80° W (Panama). Furthermore, distribution maps according to rainfall conditions at the origin sites are presented. Their potential for eventual germplasm selection aiming at cultivar development is discussed. Then, with focus on Venezuela from where particularly much germplasm and herbarium information is available, a map of probable distribution of *C. brasilianum* is presented. Since the FloraMap™ software only considers climate information, our study recurs to a second important data source, the soil and terrain database SOTER, which is concerned with soil properties. By combining FloraMap™ with SOTER, and applying appropriate GIS technology, it was possible to create a map of Venezuela showing various levels of probability regarding regions where *C. brasilianum* can be expected to occur and, thus, where future collection missions should concentrate. High probabilities were identified for some regions of the state of Zulia, the west of Guárico, Anzoátegui and the northern part of Bolívar.

Keywords: Biodiversity, Biogeography, *Centrosema brasilianum*, GIS, Latin America, pasture legume, Venezuela

Contact Address: Sarah Schneider, University of Hohenheim, Institute for Plant Production and Agroecology in the Tropics and Subtropics, Garbenstrasse 13, 70599 Stuttgart, Germany, e-mail: sarahschneider@gmx.net

Spatial Structure Analysis Using Three Different Approaches

AMANDA BARBOSA LIMA, JOSÉ JAVIER CORRAL RIVAS, KLAUS VON GADOW, UWE MUUSS

Georg-August-University Göttingen, Institute of Forest Management, Germany

Forest structural diversity, which may be defined as the diversity of tree species and tree dimensions and their spatial arrangement, can be indicative of overall biodiversity and habitat suitability. The ability to assess and to describe spatial structures with affordable cost is the key to managing uneven-aged multi-species forests. The knowledge of forest structure is useful in forecasting tree growth and for monitoring the modifications caused by timber harvesting operations. Many authors have suggested variables that can be used to describe forest structure and diversity, and numerous structural indices have been proposed. To assess the different scales and levels of forest structure within a given area, more integrated and comprehensive approaches are required which include not only species diversity (i.e., mixture), but also the distribution of the tree positions (i.e., spatial distribution) and the special arrangement of the tree dimensions (i.e., size differentiation). One of the main problems is to characterise and describe forests with different spatial characteristics more accurately, using affordable assessment techniques. This study describes an analysis of three groups of indices: **(1)** aggregation index of Clark and Evans combined with the segregation index of Pielou and the Shannon index (i.e., macroscale structure analysis), **(2)** the three neighbourhood-based parameters "contagion", "species mingling" and "dominance" (i.e., microscale structure analysis), **(3)** pair-correlation function and Mark-correlation function which is based on point pattern analysis (i.e., surface analysis). The specific forest structures were studied using fully enumerated plots with measured tree positions from three different forest types: a subtropical forest from Southern Africa, a temperate forest from Europe and a boreal forest from Northern Mongolia. The neighbourhood-based variables proved to be equally effective as the other variables for characterising small-scale differences of forest structure, but have the advantage that they are easier to assess during forest inventories than the traditional measures of forest spatial structure and diversity.

Keywords: Aggregation index of Clark and Evans, neighbourhood-based parameters, point pattern analysis, segregation index of Pielou, Shannon index, spatial forest structure

Contact Address: Amanda Barbosa Lima, Georg-August-University Göttingen, Institute of Forest Management, Büsgenweg 5, 37077 Göttingen, Germany, e-mail: amandablima@hotmail.com

Application of the Land Resources Information System SLISYS in the Oueme Basin of Benin (West Africa)

THOMAS GAISER[1], HEIKE WEIPPERT[1], ATTANDA MOUINOU IGUE[2], KARL STAHR[1]

[1]*University of Hohenheim, Institute for Soil Sciences and Land Evaluation, Germany*
[2]*National Institute for Agricultural Research of Benin (INRAB), Benin*

The objective of the soil and land resources information system SLISYS for the Oueme basin in Benin is the estimation of long-term evolution of crop yields and of diffuse emissions from agricultural land into water bodies in relation to climate and land management changes.
SLISYS-Oueme was created to provide data about soils, climate and terrain conditions in the Oueme basin. The data domain of SLISYS-Oueme contains soil information based on the SOTER map of Benin, climate information from 133 meteorological stations distributed in the whole country as well as model specific data on crop management. Land cover is derived from a LANDSAT TM PLUS interpretation from the year 2003 (Igue et al. 2006). On the land cover unit "Mosaic of fallow and cultivation", 16 crops as well as fallow land are distinguished considering crop specific management with respect to fertilisation, irrigation and length of fallow period. SLISYS-Oueme contains a spatially distributed model for the estimation of diffuse emissions at a high spatial and temporal resolution. The estimation of crop yields for the 16 crops is based on simulations with the agroecosystems model EPIC (Erosion Productivity Impact calculator, USDA 1990). The basin has been subdivided into hydrological response units (LUSAC: land use-soil association-climate unit) which are quasi-homogenous with respect to land use, soil and climate. EPIC calculates the crop yields for each LUSAC unit. The results are then aggregated to the department or subbasin scale according to the area coverage of each LUSAC. As an example for potential applications of SLISYS, calculations of actual and nutrient limited crop yields as well as the effects of fallow systems on crop productivity at the department level are presented

Keywords: Benin , crop production, information system, land resources

Contact Address: Thomas Gaiser, University of Hohenheim, Institute for Soil Sciences and Land Evaluation, Emil-Wolff-Straße 27, 70593 Stuttgart, Germany, e-mail: tgaiser@uni-hohenheim.de

Land Use/cover Map and their Accuracy in the Oueme Basin of Benin (West Africa)

ATTANDA MOUINOU IGUE[1], JEAN COSSI HOUNDAGBA[2], THOMAS GAISER[3], KARL STAHR[4]

[1]*National Institute for Agricultural Research of Benin (INRAB), Benin*

[2]*University of Abomey-calavi,*

[3]*University of Hohenheim, Institute for Soil Sciences and Land Evaluation, Germany*

[4]*University of Hohenheim, Soil Science and Petrography, Germany*

In the scope of the European Union water initiative for developing countries, the research programme RIVERTWIN (A Regional Model for Integrated Water Management in Twinned River Basins) was initiatited for three river basins, Neckar in Germany, Oueme in Benin Republic and Chirchik in Uzbekistan.

Our contribution in this work is to establish a soil and land resources information system (SLISYS). The objectives of SLISYS is to provide information about soils, climate and terrain conditions in the Oueme basin, to estimate crop yield in relation with soil quality and land management and to assess the extent of diffuse pollution from agricultural production. Apart from soil and climate information, the distribution of crops and land management practices is crucial to achieve the above mentioned objectives. Therefore, a land use/cover map has been established at the scale 1:200.000 from satellites images LANDSAT TM Plus of 2003 from 3 scenes. After image treatment, imaged maps were established and interpretation keys were defined. For efficacy reasons, the interpretation was carried out at the scale of 1:50.000 in order to get maximum information. Field controls were done during one month. More than 650 observations points were checked during the ground checks. Finally, 17 land use/cover classes were defined.

The subsequent accuracy check shows that the overall interpretation accuracy is high (89 %). The land use unit “mosaic of cultivation and fallows” has been interpreted most precisely, whereas the classification of the unit “humid and dry dense forest” has the lowest precision. Crops and fallow land were then distributed within the land use unit “mosaic of cultivation and fallow” according to agricultural statistics from 2003.

Keywords: Accuracy, Benin , land use/cover classification, RIVERTWIN project, Satellite images

Contact Address: Attanda Mouinou Igue, National Institute for Agricultural Research of Benin (INRAB), Rue de l’IITA Togoudo, B.P. 988 Cotonou, Benin, e-mail: igue_attanda@yahoo.fr

Social-economical Database Implementation into GIS to Analyse Land Suitability for Citrus Fruit Production: A Case Study in the Thua Thien Hue Province, Vietnam

CHUONG VAN HUYNH[1], MICHAEL BÖHME[2], MICHAEL LA ROSA[3]
[1]*Humboldt-University Berlin, Faculty of Agriculture and Horticulture, Germany*
[2]*Humboldt-University Berlin, Horticultural Plant Systems, Germany*
[3]*Humboldt University Berlin, Horticultural Economics, Germany*

Agricultural land suitability analysis and land use planning is being considered as a very complex process usually solved by multi-criteria and interdisciplinary approaches. In general, land suitability analysis takes into account the influences of physical in relation to socio-economic, infrastructure and environmental issues for agricultural crops. The study aims at integrating the socio-economic, infrastructure databases into GIS together with the physical data for land suitability analysis. A case study in an area of about 6637 hectare in Thua Thien Hue Province, Vietnam has been conducted. This area is characterised by 4 major soil groups with 16 soil units; slopes ranging from 3° -15°, topsoil depths from 30 cm to more than 100 cm; scarce water resources, summer drought and winter heavy rain; very poor to moderate soil fertility. The rural infrastructures and socio-economic status are underdeveloped and not very attractive for agricultural development. Growing local citrus species in smallholder farms at low management and investment level using mainly family labour with potential to extension of cultivated area is the land use type proposed for this study. Through the integration of physical, socio-economic and infrastructure data in GIS, suitability level analysis and criteria development could be divided into two stages: land physical and socio-economic and infrastructure evaluations. The study has proved that the integration of databases into GIS is a very powerful and robust tool for land suitability analysis and decision making process. Besides the physical factors, the socio economic and infrastructure factors used in this study mainly consist of 5 main criteria (rural road systems, inputs-market-prices, accessibility to technology, capital and labour availability, institutions and policies) with 3–6 sub criteria for each main criterion. The result showed that all those factors affected the suitability for citrus fruit production. Market-prices, inputs and technology in socio-economic group and low soil fertility, scarce water resources in physical group are main constraint factors for decision of area extension. It can be concluded that the investigated area is marginally till moderately suitable for citrus fruit production.

Keywords: Citrus, GIS, land suitability, physical factors, social-economic factors

Contact Address: Michael Böhme, Humboldt-University Berlin, Horticultural Plant Systems, Lentzeallee 75, 14195 Berlin, Germany, e-mail: michael.boehme@rz.hu-berlin.de

Monitoring of Land Use Intensification and Linkage to Soil Erosion in Nigeria and Benin

BIRTE JUNGE[1], KARL STAHR[2]

[1]*International Institute of Tropical Agriculture (IITA), Soil Science Unit, Nigeria*

[2]*University of Hohenheim, Institute of Soil Science and Petrography, Germany*

Since the 1960s, a dramatic acceleration in urban growth has unfolded in sub-Saharan Africa. The increasing population density involves the intensification of land use through expansion of the cultivated area and shortening of the fallow period. Not adapted land use practices inevitably lead to soil degradation like loss of topsoil due to water erosion. Avoidance of soil deterioration by enhanced conservation is therefore necessary to maintain its productivity and to contribute to food security and poverty alleviation in rural communities.

The study presents the intensification of land use and the evolution of soil erosion features for some pilot villages across a transect from the Derived to Northern Guinea Savannah of Benin and Nigeria. For monitoring land use and erosion within the last decades, aerial photographs from the sixties and seventies and the satellite images LANDSAT 7 ETM (1999, 2000 and 2001) and IKONOS (2000) were interpreted. Interviews concerning past and current farming systems, tillage, use of crop residues etc. as well as the development of the families also were made in the study areas.

The interpretation of photos and images clearly shows the increase of farm land within the last decades. The cultivated area of many pilot villages has reached the border of neighbouring settlements, and there is no fallow in many places any more. Only one test site located in Central Nigeria is characterised by recent settlement of different tribes due to the availability of fertile soil. The analyses and questionnaire also show that the land use system in Southern Benin is characterised by oil palm trees and maize. Systems with cereals and root crops dominate in the centre of Nigeria and with sorghum/maize or pearl millet and cowpea in Northern Nigeria. Legumes like cowpea or groundnut have been introduced into the farming systems in the last decades. Linear soil erosion features that were infrequently extended in the sixties and seventies have spread until now. Sheet erosion has already led to the exposure of iron pan on lower slopes and destroyed farm land in some pilot villages of Northern Nigeria.

Keywords: Benin, land use intensificaiton, Nigeria, soil erosion

Contact Address: Birte Junge, International Institute of Tropical Agriculture (IITA), Soil Science Unit, Oyo Road, Ibadan, Nigeria, e-mail: b.junge@cgiar.org

Range Condition Evaluation in Empedrado, Corrientes - Argentina

DITMAR BERNARDO KURTZ[1], MARIA CRISTINA GOLDFARB[2], FRANCISKO NUNEZ[2], OSCAR QUIROS[2]

[1]*University of Bonn, Institute of Crop Science and Resource Conservation - Crop Production, Germany*

[2]*National Institute for Agricultural Technology, Corrientes, Argentina,*

The total area of rangelands constitutes 78 % of the Empedrado department surface (Corrientes province — Argentina). Rangeland evaluation is considered essential part of a good management and sustainable use of the grassland resource. Worldwide, different tools with different complexity are available, from field to remotely based procedures. In these work, both approaches were investigated. For that reason, two sampling sites were considered: highlands and lowlands, both selected regarding accessibility and representativeness. In each field site, several attributes were recorded in a nine-block design of 28.5 m $\times$ 28.5 m. and five random samples within. In the laboratory, normalised difference vegetation index (NDVI) was calculated from a Landsat 5 TM image (path 226, row 079) acquired on 27 July 2006 coincident with the fieldwork date. In addition, trend and cover index was calculated as an indicator of range condition.

The results indicate that in the highland site, weeds contributed with 49.1 % whilst grasses contributed with 48.6 % of the species. Dry matter yield (DMY) was 3,506 kg/ha; weeds contributed 2,295 kg/ha (65.5 %) and grasses 1,180 kg/ha (33.7 %). Species that contributed to total DMY were: *Vernonia chamaedrys* (50.1 %), *Sorghastrum agrostoides* (13.7 %), *Eryngium horridum* (11.3 %) and *S. nutans* (10.9 %). In the lowlands, grasses contributed up to 97.3 % and grasslike plants about 2.3 %. DMY was 2,287.1 kg/ha and grasses contributed 2,225 kg/ha (97.3 %). Species that contributed more to total DMY were: *Paspalum intermedium* (45.4 %), *S. agrostoides* (26.7 %) and *Andropogon lateralis* (18.3 %). Statistical analyses indicate that the two sites are significantly different regarding standing death material, total DMY and NDVI. Additionally, the trend and cover index was sensitive to detect the different range conditions, being higher in the lowland site than in the highland site. No significant differences were found when considering mulching and percentage of bare soil. Interestingly, NDVI and trend and cover index show to be inversely related. The ongoing results suggest further studies to take advantage of the remote sensing techniques.

Keywords: Landsat, normalised difference vegetation index, rangelands, trend and cover index

Contact Address: Ditmar Bernardo Kurtz, University of Bonn, Institute of Crop Science and Resource Conservation - Crop Production, Nussallee 1, 53115 Bonn, Germany, e-mail: dkurtz@uni-bonn.de

Leaf Senescence Patterns in Cowpea and Assessment of Chlorophyll Depletion by Digital Imaging.

CLAUDIA SANETRA, HELMUT HERZOG

Humboldt University Berlin, Crop Science in the Tropics and Subtropics, Germany

Leaf senescence patterns were investigated with three genotypes of cowpea (*Vigna unguiculata* L. Walp.). The progression of leaflet abscission at the main stem was recorded during the reproductive phase. At harvest, the genotype Lobia had only 8 % of its leaflets abscised, while RCXAC and IFH 27–8 had 29 % and 95 % leaflets shed, respectively. Leaf senescence progressed from the bottom of the plants, but in IFH 27–8 there was a sudden leaf shedding at maturity. The senescence pattern with its genotypic survival rates of leaflets could be related to the distinct patterns of blooming and new pod development of the genotypes. A diagram depicting the time period of blooming showed two connected peaks for Lobia, two separated peaks for RCXAC and only one for IFH 27–8. Furthermore, it remains to be investigated whether the different leaf senescence patterns express differing strategies to use resources for pod production. At harvest, Lobia produced more pods per plant than the other two genotypes, but because of a higher amount of seeds per pod and higher kernel weight, seed yield was higher in IFH 27–8.

A method to estimate chlorophyll depletion by digital imaging is being developed. Chlorophyll analysis of leaflets of various stages of depletion was carried out for all genotypes and the data obtained were then related to the average green intensity value from imaging. This value was calculated by the software tool integrating the colour values of single pixels and the pixel number of the total leaflet area. A highly significant correlation including 6 genotypes may represent a standard curve for cowpea in general.

Keywords: Chlorophyll, cowpea, digital imaging, leaf senescence

Contact Address: Claudia Sanetra, Humboldt University Berlin, Crop Science in the Tropics and Subtropics, Albrecht-Thaer-Weg 5, 14195 Berlin, Germany, e-mail: claudia.sanetra@agrar.hu-berlin.de

The Digital Global Map of Irrigation Areas — Development and Validation of Map Version 4

STEFAN SIEBERT[1], JIPPE HOOGEVEEN[2], PETRA DÖLL[1], JEAN-MARC FAURES[2], SEBASTIAN FEICK[1], KAREN FRENKEN[2]

[1]*University of Frankfurt (Main), Institute of Physical Geography, Germany*

[2]*Food and Agriculture Organization of the United Nations, Land and Water Development Division, Italy*

A new version of a digital global map of irrigation areas was developed by combining irrigation statistics for 26909 sub-national statistical units and geo-spatial information on the location and extent of irrigation schemes. The difference to map version 3 (available at: http://www.fao.org/ag/agl/aglw/aquastat/irrigationmap/index.stm) is the incorporation of a map update for Africa, Europe and parts of Latin America. The map shows the percentage of each 5 arc minute by 5 arc minute grid cell (about 86 km^2 along the equator) that was equipped for irrigation around the year 2000. It is thus an important data set for global studies related to land and water, but also for assessments on food security or to quantify possible impacts of climate change on agriculture. The poster describes the data set and the mapping methodology and gives an estimate of map quality at the scale of countries, world regions and the globe. Two indicators of map quality were developed for this purpose, and the map was compared to irrigated areas as derived from remote sensing based global land cover inventories. The main results of the study are, that 278.8 Mio ha were equipped for irrigation at the global scale. About 68 % of the total irrigated area is located in Asia, 17 % in America, 9 % in Europe, 5 % in Africa and 1 % in Oceania. The largest contiguous areas of high irrigation density are found in North India and Pakistan along the rivers Ganges and Indus, in the Hai He, Huang He and Yangtze basins in China, along the Nile river in Egypt and Sudan, in the Mississippi-Missouri river basin and in parts of California. Smaller irrigation areas are spread across almost all populated parts of the world. At the global scale, the overall map quality is good, but there are large regional differences of map quality. It was found that remote sensing based land cover inventories report higher values for the global extent of irrigated land and that there is a need for a systematic comparison of the different data sets.

Keywords: Agriculture, crop management, crop production, global map, irrigation, irrigation map, land cover, land use, water use

Contact Address: Stefan Siebert, University of Frankfurt (Main), Institute of Physical Geography, Georg Voigt Str. 14, 60325 Frankfurt, Germany, e-mail: s.siebert@em.uni-frankfurt.de

Model Use in Agriculture

Comparison of Flood Prediction Models for River Lokoja, Nigeria

JOHNSON FASINMINRIN, AYORINDE OLUFAYO
Federal University of Technology, Department of Agricultural Engineering, Nigeria

Flood estimation is one of the major aspects of hydrologic designs and is vital in planning for flood regulation and protection. This research work was aimed at comparing prediction models for forecasting flood occurrences in River Lokoja, in Kogi State Nigeria. Relevant climatic data such as rainfalls, flood discharges and river stages of 24 years duration (1980 — 2003) were collected from Lower Niger River Basin Authority based in Lokoja. Variations in rainfall distribution were analysed and five plotting positions: California, Cunnanae, Grigortons, Hazens and Weibull were used to compute the return periods for the observed flood discharges. Flood magnitudes and the corresponding return periods were plotted by fitting the used plotting positions into the Log-Pearson Type III distribution. The derived prediction equations (models) from the plots of discharge against return periods were used to forecast flood magnitudes for 5, 10, 15, 20, 25, 50, 100, 200, and 500 years return periods. Results showed that the highest rainfall occurred between the months of August and September. Standard deviation, skew and variance of rainfall were 83.28, 0.287 and 6935.13 respectively. The rating curve for River Lokoja showed that an exponential relationship exists between the river stage and the associated discharge with reasonably high coefficient of correlation (0.09). Plot of river discharge against the return period showed that the maximum flood discharge (2.39×104 m^3s^{-1}) had a 25 year return period using the Weibull's distribution. Derived prediction equations (models) gave flood magnitudes of 2.60×104 m^3s^{-1}, 2.56×104 m^3s^{-1} for a return period of 50 years using the Weibull, Grigorton and California plotting positions respectively. These results are very useful in predicting magnitudes of flood occurrences and their effects on Lokoja metropolitan city.

Keywords: Discharge, flood, rainfall, rating curve, Return period

Contact Address: Ayorinde Olufayo, Federal University of Technology, Agricultural Engineering, P. M. B. 704, 341000 Akure, Nigeria, e-mail: ayo_olufayo@yahoo.com

A Land Resource Database for Land Evaluation Modelling in the Tocuyo River Basin, Venezuela

ONELIA ANDRADE, STEFAN ERASMI, MARTIN KAPPAS
University of Göttingen, Institute of Geography, Cartography, GIS & Remote Sensing Sect., Germany

Tocuyo River Basin is the most important hydrographical ecosystem in the Center-Western region of Venezuela. Population growth and urban expansion in the basin have caused a degradation of natural resources, an increase of soil erosion risk, and a relative land scarcity for agricultural uses, therefore land evaluation to optimise the land use is necessary.
Land evaluation involves the assessment of land performance used for a specific purpose, involving the execution and interpretation of surveys and studies, of all aspects of land to identify and make a comparison of promising kinds of land use applicable to the objectives of the evaluation. It is, therefore, necessary to obtain, analyse and interpret detailed information of all factors that interact with the land to proposing an integral management of this basin.
In this study a methodology has been established, integrating remotely sensed imagery from Landsat-7, ETM+ (WRS^{-2}, P/R: 6/53), digital elevation model (SRTM), 1:100.000 scale topographic and thematic maps, ground survey methods, and digital data in a geographic information system (GIS). A new cadastre based on a GIS with information about land forms, geology, hydrology, vegetation, soils, climate, infrastructure land cover, land use changes is developed to have a database in digital format for a detailed survey of the study area.
The resulting information especially that related with land use/land cover patterns and their spatial distribution is a prerequisite for planning sustainable development of the region. It can be successfully used in land use/land cover change detection analysis, determination of soils erosion risk, and identification of land units for land evaluation. These objectives are underway.

Keywords: Land evaluation, land resources database, Tocuyo river basin, Venezuela.

Contact Address: Onelia Andrade, University of Göttingen, Institute of Geography, Cartography, GIS & Remote Sensing Sect., Goldschmidtstr. 5, 37077 Göttingen, Germany, e-mail: oneliaandrade@yahoo.es

Future Scenarios of Biomass Dynamics under Pastoral Conditions and Regional Water Balance Aspects for the Drâa Catchment in South-eastern Morocco

ANDREAS ROTH, FRANK GRESENS, JÜRGEN BURKHARDT, HEINER GOLDBACH
University of Bonn, Institute of Crop Science and Resource Conservation - Plant Nutrition, Germany

The process-oriented and spatial explicit ecosystem model SAVANNA is used to assess biomass dynamics in rangeland landscapes in south-eastern Morocco. This region has been facing continuous droughts during the past 30 years, forcing semi-sedative farmers and nomads to deal with low ground water levels and highly variable patterns of yield and vegetation. Variances of stocking rates and thus economic uncertainty are the results. Model scenario results with a prospective to 2020 are expected to develop useful strategies relying to transhuman decision making.
The model was calibrated for rangeland areas of the Drâa river catchment, located between the High Atlas mountains in the north and the Lac Iriki pan in the south. Measurements of biomass (kg/ha) and plant component parameters (g/m^2 DWT, Dry Weight Matter) of many saharan, iranoturanean and oromediterranean species were collected for calibration purposes. These species are the basic nourishment of trespassing nomadic and sedentary herds. Multiple simulation runs with 'no grazing' and 'grazing' conditions were carried out. for calibration and sensitivity analysis with three basic SAVANNA vegetation types: herbaceous (e.g. *Stipa* ct. *parviflora*), shrub (e.g. *Artemisia herba-alba*/*-mesatlantica*) and woody (e.g. *Juniperus pho.*). Model results were used to determine regional influences of sheep, goat and dromedare herd populations on vegetation cover, species composition and distribution in order to assess their influence on the local/regional water cycle.

Keywords: Biomass dynamics, ecosystem modelling, herd dynamics, Morocco, transhumance

Contact Address: Andreas Roth, University of Bonn, Institute of Crop Science and Resource Conservation - Plant Nutrition, Karlrobert-Kreitenstrasse 13, 53115 Bonn, Germany, e-mail: aroth@uni-bonn.de

Analysis of Water Use and Allocation for the Khorezm Region in Uzbekistan Based on an Integrated Economic-hydrologic Water Management and Planning Model

TINA SCHIEDER
University of Bonn, Center for Development Research (ZEF), Germany

Water availability and an effective and sustainable management of water resources is an important factor in social and economic development. This applies notably for the case study area. The highly arid area Khorezm is situated in the Central Asian Republic of Uzbekistan and the Amu Darya delta region. Due to historical and recent expansion of irrigation projects the region is highly dependant on water for irrigation purposes. But inefficient water consumption and management result in drastic ecological, social, and economical problems like rise of soil and water salinity, water scarcity, declining yields, health problems and rising groundwater levels. This development and an increasing competition among water users within the region and between up- and downstream areas along the river calls for a more efficient water allocation and management approach.

In the presented study a regional analysis for different spatial resolutions of water allocation and use and effects of alternative water management strategies and policies to hydrologic cycles, plant growth, yields and areas and farmers is carried out for the Khorezm Region. The main objectives of the study will be the detection and determination of water supply and demand and as a consequence thereof the water availability and water use patterns in the region of Khorezm. Based on agronomic, hydrologic and climatologic fundamentals and calculations, economic consequences of alternative more effective water uses, management and allocations shall be determined and analysed and can serve as policy recommendations.

The water allocation model is programmed in Gams (General Algebraic Modelling System) and is made of a system of non-linear differential equations. The development of such a framework of analysis can be a step to integrate different disciplines (natural sciences, economics, social sciences) to find out a better water management including efficient, equitable, and environmentally sustainable water allocation mechanisms for the study area.

Keywords: Gams, integrated hydrologic-economic model, irrigation, optimisation model, Uzbekistan, Water allocation

Contact Address: Tina Schieder, University of Bonn, Center for Development Research (ZEF), Rheinbacher Straße 2, 53115 Bonn, Germany, e-mail: tina.schieder@uni-bonn.de

Application of the Epic Model in the Oueme Basin (Benin, West Africa) - Simulation of Crop Productivity and Nitrogen Dynamics

FRANK-MICHAEL LANGE, FIRESENAI SEREKE, STEFANIE COLOMBO
Terra Fusca, Engineering and Consulting, Stuttgart, Germany

Water resources in developing countries are under increasing pressure from the continuous growing demand for sufficient quantities of good quality water for all purposes. The European Union Water Framework Directive introduces interdisciplinary and holistic considerations for entire river basins. Therefore, decision support systems that integrate water balance models are a helpful tool to establish river basin-management plans. The EU-funded project RIVERTWIN aims at refining, testing and implementing an integrated regional model to facilitate water resource management in twinned river basins. One part of the RIVERTWIN Project was to simulate crop productivity and the impact of specific cropping systems on the nitrogen dynamics under varying climate and soil conditions and different fertilisation levels in the Oueme Basin (Benin). The specific objective of the study was to evaluate the potentials of the EPIC model to support the understanding of N dynamics of specific cropping systems in order to avoid the risk of N leaching from agricultural sites without sacrificing crop yield at the same time. Therefore, over 43 cropping seasons with various fertiliser inputs and contrasting soil and climate conditions were simulated in the Oueme Basin. The EPIC simulations were based on daily weather data recorded close to the research sites, detailed soil information and daily records on farming activities. To summarise the results of testing the EPIC simulation model, the following conclusions can be drawn: Crop yields were predicted with reasonable accuracy for sites with good data availability, whereas the simulation results didn‘t correspond well with observed yields for sites located at farmer fields and local crop varieties. For the case of local varieties the agronomic characteristics of the simulated crops included in EPIC were adjusted to obtain yields closer to local yields. Generation of supplementary model inputs continue to pose a major task for the Oueme Basin research area. Based on the results of the testing of the Epic submodel, our conclusion is that the model could be satisfactorily employed in the assessment of agricultural productivity and environmental impact, since it incorporates as much data as possible based on land management, climate and soil conditions.

Keywords: Crop productivity, Epic, local varieties, modelling, nitrogen dynamics

Contact Address: Frank-Michael Lange, Terra Fusca, Engineering and Consulting, Stuttgart, Wollgrasweg 27, 70599 Stuttgart, Germany, e-mail: lange@terra-fusca.de

Assessment of an Improved Fallow Agroforestry System in the Peruvian Amazon through Modelling Approach

BOHDAN LOJKA, JANA LOJKOVA, DANIEL PREININGER, JAN BANOUT, ZBYNEK POLESNY

University of Agriculture Prague, Institute of Tropics and Subtropics, Czech Republic

As traditional slash-and-burn systems with prolonged fallow periods are no longer feasible in most parts of the tropics, improved agroforestry systems have high potential to increase the productivity of farming systems and sustain continuous crop production. Our objective was to assess biophysical and economic performance of planted leguminous tree fallow (using *Inga edulis*) compared to traditional slash-and-burn farming system, practised by farmers on fields infested with noxious weedy grass *Imperata brasiliensis* around the city of Pucallpa, Peru. The evaluation consists of two parts. An existing agroforestry model SCUAF was used to predict biophysical factors, such as changes in soil characteristics and farm outputs (crop and tree yield). While a cost-benefit analysis spreadsheet, which uses the output from SCUAF and economic data on input/output levels and prices, calculates economic performance of the systems. The Inga fallow system can provide improvements to a range of soil biophysical measures (C, N, P content). This enables higher levels of farm outputs to be achieved (higher cassava yields). However, for smallholders the improved system must be more economically profitable than the existing one. At prices currently encountered, the Inga fallow system is more profitable than the *Imperata* fallow system only in long term. The time taken for the smallholders to convert from the current system to the new system is important. In adopting the Inga fallow system, smallholders will incur lower profits in the first years, and it will take approximately ten years for smallholders to begin making a profit above that achievable with the *Imperata* fallow system. Unless smallholders are capable of accepting the lower profitability in the first years, or there is some government assistance, or a kind of incentive, they are less likely to adopt the new system.

Keywords: Cost-benefit analysis, *Imperata brasiliensis*, improved fallow, *Inga edulis*, SCUAF, slash-and-burn

Contact Address: Bohdan Lojka, University of Agriculture Prague, Institute of Tropics and Subtropics, Kamýcká 129, 169 21 Prague, Czech Republic, e-mail: lojka@itsz.czu.cz

Modelling Sorghum Yield in Response to Inorganic Fertiliser Application in the Semi-arid Region of Ghana

DILYS SEFAKOR KPONGOR, PAUL L. G. VLEK, ROLF SOMMER
University of Bonn, Center for Development Research (ZEF), Germany

Agriculture in the Guinea-savannah of Ghana is the main basis of livelihood for the people. Agriculture employs about 80 % of the population and is characterised by low external inputs. Soils in this area are light textured and inherently low in organic carbon, cation exchange capacity, nitrogen and phosphorous. Sorghum is one of the important staple crops cultivated in this region. Its successful and viable cultivation is, however, restricted to compound farms where animal manure is applied to increase soil productivity and yields. On the other hand, sorghum yields of the more remote, so called bush farms are notoriously low. Bush farms conventionally relied on long fallows to restore some moderate soil fertility, and are nowadays less productive partly due to the shorter fallows and annual bush burning in the area. This is worsened by the transfer of nutrients through the removal of crop residues from the bush farms to use as feed and beddings for animals around the compound. Under these conditions, the demand for sorghum outweighs the level of production from the compound farms resulting in seasonal famine. Hence, there is the need to explore means of increasing the production of sorghum.

This study seeks to assess and predict the inorganic fertiliser yield response of sorghum on both compound and bush farms. To achieve this, experiments were conducted with three levels of inorganic phosphate and four levels of N fertiliser application. The plots were laid out in a randomised complete block design with four and seven replicates in bush and compound farms, respectively. The DSSAT crop-soil simulation model is used to simulate sorghum crop yields. It uses soil, weather, and crop management data as input parameters. The model is currently being calibrated and will be used to forecast Sorghum yield in this region over the next 10 years using generated weather data and different management and fertilisation scenarios. The model is anticipated to support the identification of the most promising management of inorganic fertiliser application in Sorghum production in both management systems.

Keywords: Modelling, Soil productivity, Sorghum yield

Contact Address: Dilys Sefakor Kpongor, University of Bonn, Center for Development Research (ZEF), walter flex str. 3, 53113 Bonn, Germany, e-mail: kpongor@yahoo.com

Determining the Development Rates of Grape Berry Moth Stages

KAI SCHMIDT[1], MIRJAM HAUCK[2], HARTWIG HOLST[2]

[1]*University of Bonn, Mathematical Seminar, Germany*

[2]*State Research Station Geisenheim, Department of Phytomedicine, Germany*

The grape berry moth Lobesia botrana, a severe pest of vineyards and stone fruits, completes its life cycle within two and occasionally three generations in Northern Europe, while in the Mediterranean climates of the Near East four generations are common. Due to the cryptic nature of the developing larvae that feed inside the berries, just the short time window from egg oviposition to egg hatch is applicable for control, as emerging larvae are fast to dwell into the berry where they are sheltered from insecticides. To estimate this crucial window within each generation the rates of the development stages have to be determined. Development is most obvious a non-linear function of temperature. Hence, a set of climate chamber experiments were established to monitor the development of the moth stages at constant temperatures in the range of 10°C to 28°C. The data provide information about the longevity of adult males and females, egg production and the population dynamics of the stages L1, L2-L4 and pupae, as these vary with temperature. The results were used a) to estimate the parameters of the related temperature response functions of each stage and b) to provide the parameters for an age structured Leslie model. As a result the complete life cycle of the moth is summarised to a constant parameter vector of the model, which is applicable for a large range of temperature patterns. Applying the Leslie model with its estimates, taken from the results of the climate chamber experiments, to long-term field data demonstrates both the importance and need of constant temperature experiments as well as the possibilities of upscaling laboratory results to field situations.

Keywords: Grape berry moth, modelling, parameter estimation, pest control

Contact Address: Kai Schmidt, University of Bonn, Mathematical Seminar, Nussallee 15, 53115 Bonn, Germany, e-mail: kai.schmidt@uni-bonn.de

Woody Plants in Smallholders' Farm Systems in the Central Highlands of Ethiopia: A Decision and Behaviour Modelling

MICHAEL KRAUSE[1], HOLM UIBRIG[2]

[1]*University of Kassel, Department of Development Economics and Agricultural Policy, Germany*

[2]*Dresden University of Technology, Institute of International Forestry and Forest Products, Germany*

Various strategies towards poverty reduction have been followed in rural areas of the Ethiopian highlands. In this context the contribution of woody plants to the livelihoods of farm households has widely been recognised. So, the contemporary depletion of natural forests and deforestation due to the massive use of tree produce and agricultural land expansion drives research on deliberate tree growing on-farm.

Farmers' perceptions of the utility and the constraints of locally available woody species were assumed to influence the decision making and the behaviour of tree integration into current land-use types. Accordingly, the objectives of this study have been **(1)** to analyse farmers' decisions in making use of woody plants under perceived constraints and **(2)** to analyse influencing factors that determine the deliberate tree growing behaviour.

The methodology of this study based on the approaches of the 'Farming Systems' and the 'Behavioural Decision-Making'. Influence diagrams were constructed incorporating the perceived utility and decision determinants of deliberately grown woody plants. The 'Discriminant Analytical Approach' served to model farmers' tree adoption behaviour referring to external and internal influencing factors. Two villages were selected in the central highlands to contrast **(i)** two agro-ecological zones and **(ii)** different access to markets for tree produce. A standardised questionnaire constituted the major tool for surveying 130 systematic-randomly selected and ex-post stratified households.

Results from the decision modelling revealed that woody plants are grown on-farm according to the perceived utility of species, predominantly fuelwood and timber-based produce, followed by cash-generation. Service functions pertaining to the protection of land gain secondary importance to tree produce. Major decision determinants comprise resource-based factors, e.g. the shortage of land and seedlings, over stochastic-environmental factors. The competition with agricultural crops for resources is decisive to consider woody species not disturbing the agricultural production. Results of the 'Discriminant Analysis' confirmed that the adoption of trees is characterised by the available resource base, the access to infrastructure and support services as well as by personal characteristics of the farmers. If access to the market is given, the deliberate growing of trees renders additional cash income and thus contributes to the liquidation of farms.

Keywords: Behavioural decision-making, discriminant analysis, farming systems, land-use pattern, non-competitive tree integration

Contact Address: Michael Krause, University of Kassel, Department of Development Economics and Agricultural Policy, Steinstrasse 19, 37213 Witzenhausen, Germany, e-mail: krause@uni-kassel.de

Participatory 3d Modelling in Bonga, South-western Ethiopia

FRIEDERIKE TÄSTENSEN

Carl-von-Ossietzky University of Oldenburg, Landscape Ecology, Germany

The participatory 3D modelling approach presented herein bases on a publication by RAMBALDI and CALLOSA-TARR from 2001. The work was carried out as part of a diploma thesis conducted in the Bonga region of south-western Ethiopia during a three month field trip in 2005. For the purpose of this thesis, titled 'Conservation areas for wild coffee in Ethiopia: an exemplary planning concept based on land use', the original approach developed in and for the Asian region was adopted.
Participatory 3D modelling basically is a Community-integrated Geographic Information System (CiGIS) (RAMBALDI AND CALLOSA-TARR, 2001). Its key focus is the establishment of means that allow ordinary people to work and understand spatial data, to create new realities e.g. the change of land uses and to provide information on the area. The approach thereby tries a much wider integration of stake holders. In the context of the thesis, the 3D modelling was used as a tool to gather spatial data on habitat types. This information in turn formed the spatial data base for the land use types. These types were also gathered through mapping in the field — in order to have two comparable data sets. For the actual participatory mapping, local farmers were invited to mark predefined habitat types and thereby expatiate their expert knowledge. The presentation will give an overview over the possibilities of 3D modelling as a CiGIS, highlight key differences between the work conducted and the original approach, and give details on the lessons learned. It will also give hands-on tips on the construction of a basic model, the documentation of the modelling process as well as the finished model, and the organisation of modelling sessions.

Keywords: 3d, CiGIS, Ethiopia, gIS, modelling, participartory, spatial information

Contact Address: Friederike Tästensen, Carl-von-Ossietzky University of Oldenburg, Landscape Ecology, Binsenstrasse 19, 26129 Oldenburg, Germany, e-mail: friederike.taestensen@4o2.de

Exploring Trade Offs Around Farming Livelihoods Activities in Smallholder Crop Livestock Systems in Kenya

STANLEY KARANJA NG'ANG'A[1], JAMES KUNG'U[2], PABLO TITTONELL[3], ERNESTO GONZÁLEZ ESTADA[1], DE RIDDER NICO[4], QUIROS CARLOS[1], MARIO HERRERO[1]

[1]*International Livestock Research Institute (ILRI), Kenya*

[2]*Kenyatta University, Environmental Foundation, Kenya*

[3]*International Centre for Tropical Agriculture, Tropical Soil Biology and Fertility, Kenya*

[4]*Wageningen University, Department of Plant Sciences, Netherlands*

We outline the use of the IMPACT (Integrated Modelling Platform for mixed Animal Crop systems) tool in exploring the trade offs around farming livelihoods activities in smallholder crop livestock systems in Kenya. The tool was used to collect information relating to the characteristics of the farm household (household size, labour time budgets, off-farm income and dietary pattern), as well as the physical components of the farming systems (land, crops, soils, pastures, number of plots, etc) and their management practices. Data on prices of inputs and outputs and nutrient composition of all resources were also collected. The minimum data requirement for characterising and analysing small holder mixed farming systems in Kenya was identified. The information was collected from two contrasting sites, Central and Western Kenya. IMPACT framework was then used to analyse the current livelihoods, to explore options for their development and reveal trade-offs between objectives farmers are facing in Kenya. Standard data files for running a variety of models and nutrient flows were generated for testing alternative scenarios related to poverty alleviation, soil fertility and the role of livestock. We describe some baseline results which provide summary analysis of the household's economic, food security, soil fertility balances and labour efficiency. Results on comparative system analysis of the different sites were performed on the contribution and the role of each component such as livestock, crops, and off-farm incomes sources to the farmers livelihood and trade-offs between farmers objectives are also presented. The paper concludes with discussion of an in-depth analysis that can be made out of such system using a household simulation model which is linked to the impact tool to explore option for improving farmer's livelihood.

Keywords: Households, impact, livelihoods, Smallholder farms

Contact Address: Stanley Karanja Ng'ang'a, International Livestock Research Institute (ILRI), Old Naivasha Road, +254 Nairobi, Kenya, e-mail: s.karanja@cgiar.org

Agricultural Technology

Improved Technology for the Construction of Healthy and Secure Houses in Rural Areas of the Peruvian Andes

TERESA ROJAS[1], MARTHA LAZARTE[2]

[1]*Georg-August-Universität Göttingen, Institute of Rural Development, Germany*

[2]*Ngo Alternativa,*

This paper presents a Peruvian project titled: "Training and Diffusion of Improved Adobe**(1)** Technology for the construction of Healthy and Secure Houses". This project was developed by the Japanese International Cooperation Agency (JICA) in cooperation with the Peruvian NGO Alternativa and the Peruvian governmental institution SENCICO.

As Peru is a developing country where earthquakes frequently occur, a huge impact of this project has to be expected. The selected rural areas were Lunahuana, Pacaran and Viñac which are located in the southern part of Peru. In those areas, where most of the people live in poverty, the principal activities are agriculture and livestock farming.

The aim of this project is to train and motivate local people in construction of adobe houses using an improved technology, which increase the houses' resistance to earthquakes and, as a result, improve living conditions. As health is a core issue of the project, other aspects such as construction of improved stoves and adequate management of human depositions and water, were considered as well.

Participatory methodology was used during the elaboration of the houses' prototype. Two theoretical and practical courses about improved stoves were carried out, as well as, many sessions about the use of these stoves, management of human excrements and water.

To date, 20 people are trained during two months. They were involved in the construction of two houses in Pacaran and one house is under construction in Lunahuana. Another house will be constructed in Viñac during this year. Also, two improved kitchens were constructed in Pacaran and Lunahuana. Besides that, more than 150 habitants of Pacaran, Lunahuana and near shanty towns participated in the sessions described above. As a result of that, they learned about the importance of using improved adobe technology, the health hazards of smoke generated by traditional cooking technologies in their kitchens and the necessity to manage human excrements and water. The total impact of this project will be assessed at the end of 2007.

1 Adobe is an unburnt sun-dried brick.

Keywords: Adobe technology, healthy and secure rural houses, improved stoves, Peru

Contact Address: Teresa Rojas, Georg-August-Universität Göttingen, Institute of Rural Development, Werrastr. 36, 12059 Berlin, Germany, e-mail: terojaslara@hotmail.com

Development of Pico-hydropower Plant for Farming Village in Upstream Watershed, Thailand

SOMBAT CHUENCHOOKLIN
Naresuan University, Civil Engineering, Thailand

Research on the development of Pico-hydropower plant for a farming village in Thailand was carried out. It is one aspect given by the national plan for the renewable technology development with wisely energy utilisation from natural resources included wind, water, solar energies, bio-gas, and farm waste according to the Ministry of National Energy reported, respectively. Some upstream watersheds in Thailand have potential for the development of large scale hydropower plants by means of dam constructions. However, most of proposed dam sites in the upstream watershed are located within the restricted area as for the forestry and environmental conservation zone according to the national environmental law of conservation. Pico-hydropower plant is more suitable for the economic and farming zones of such watersheds. A waterfall site in Ban-Yaeng Village, Nakornthai District in Phitsanulok Province which locates at the upstream of Wangthong Watershed (Sub-basin of Nan River) was selected as the pilot project for the construction of the hydropower plant. The appropriate technology using the centrifugal pumping machine as for the water-turbine connected to a 3-phase motor producing electricity of 380 volts at revolution of 1500 rpm was applied. The system was based on low cost of construction, local materials, and easy construction and maintenance systems. Its performance of the overall system by mean of the efficiency was found to be 52 % resulted by the effective head of 8.4 meters, flow rate of 15 liters per second, and electrical power production of 644 watts which can be used for the light, some house-ware appliances, and some farming equipments. It can be applied to other small farming villages in any upstream watershed with enough head and flow rate in the stream over the year round in order to save investment cost for farming systems with the clean technology. However, it can be transferred to larger farming villages if higher head and larger flow rate in the natural stream or river were found which depended on the country and topography.

Keywords: Pico-hydro, renewable energy, farm village, upstream watershed, rural development.

Contact Address: Sombat Chuenchooklin, Naresuan University, Civil Engineering, Faculty of Engineering Naresuan University Phitsanulok-Nkonsawan Road, 65000 Muang, Thailand, e-mail: sombatck@hotmail.com

Chemical Delinting Enhances Uniformity of Seed-dressing and the Phytosanitary Protection of Field-grown Cotton

HERMANN PLATZEN

Bayer Crop Science, Leverkusen, Germany

Modern seed dressings provide a broad and defined protection against diseases and pests of cotton. Main problems to be addressed by seed dressing include diseases of the foot root complex with *Rhizoctonia* , *Fusarium* , *Phythoptora* and *Pythium* and early sucking pests like aphids, white flies and thrips. Precondition for a uniform and effective protection of the young cotton plants against these pests and diseases is a uniform loading of the seeds with the agrochemicals. Tests were conducted to identify the possible factors resulting in uneven seed loading in various steps of the processing line. These included remnants of lint on the seed surface, large diameter of the seed, and variable amounts of dust on the seed.

The main reason for an uneven agrochemical load of cotton seeds was related to the unevenness of the lint remaining on the seed coat. The removal of this lint with sulphuric acid resulted in the highest level of evenness in chemical seed loading and provided the highest uniformity in the protection and performance of field-grown cotton. However, for seeds to be able to germinate, it is important that the acid is completely neutralised, which may be achieved with calcareous slurry or with NH_4 —gas. Chemical delinting, acid neutralisation and subsequent seed dressing with agrochemicals can all be achieved with the batch treater technology, which is suited for both commercial companies and for individual cotton growers. It may be concluded that chemical delinting is a precondition for an even agrochemical load and hence an even protection and uniform growth performance of field-grown cotton.

Keywords: Batch treater, *Gossypium hirsutum*, seed treatment

Contact Address: Hermann Platzen, Bayer Crop Science, Leverkusen, Liefenroth 38, D 51645 Gummersbach, Germany, e-mail: platzen41@freenet.de

Design of a Row Crop Weeder

OLAWALE JOHN OLUKUNLE[1], PHILIP OGUNTUNDE[2]
[1]*Federal University of Technology, Department of Agricultural Engineering, Nigeria*
[2]*University of Technology Delft, Water Management, Netherlands*

The operations involved in the crop production cycle include land clearing, land forming/land leveling, tillage, and crop establishment, harvesting and post harvest operations. Crop establishment is necessary to eliminate the effect of weeds, pests and disease infestation and to provide suitable conditions for optimum yield. More than 3000 species of weeds had been identified all over the world. The cost of weed management is enormous, however the opportunity cost of weed management is higher. Weed control measures must be put in place to check the growth and propagation of weeds. Chemical and manual weed control methods are viable alternatives; however, whereas environmental impact of herbicides made chemical method unsustainable, drudgery limits the size of farm of an individual in sub-saharan Africa. Introduction of an effective mechanical weeder is expected to encourage subsistent farmers leading to increased production and hence reducing poverty. To achieve this objective, a row crop weeder was developed in the Federal University of Technology, Akure in Nigeria. The weeder was designed, fabricated and tested and found to be very efficient. The machine consists of an abrasive nail- brush mounted on a shaft, transmission system, 5Hp engine, frame and wheels. The height of cut of the machine is adjustable, thus the machine operates as a mower when cutting height is 2 cm to 4 cm above the ground level, but works effectively as a weeder between —2 cm to 1 cm. The machine is simple, cost effective and useful for small to medium scale farm holders. It is also a positive step towards reduction of drudgery involved in row crop weeding. Zero tillage, conventional tillage (with plough and harrow) and other cultural tillage practices that would present crops on the flat are well suited for the adoption of this machine. The cost the prototype machine was estimated at 500 US Dollars (N 65,000.00). However the cost of the commercial model was estimated at 300 US Dollars (N39, 000.00). The machine is economically viable with fuel consumption limited to 8 litres per day.

Keywords: Drudgery, food security, mechanical weeding

Contact Address: Olawale John Olukunle, Federal University of Technology, Department of Agricultural Engineering, Praise Close, Peace Avenue FUTA South Gate, 0234 Akure, Nigeria, e-mail: wale_olukunle@yahoo.com

Autonomous Irrigation Management by Fluent Soil Moisture Detection

CORNELIUS JANTSCHKE, ANTON SARVAS, KARLHEINZ KÖLLER
University of Hohenheim, Institute of Agricultural Engineering, Process Engineering in Plant Production, Germany

Irrigation scheduling is essential to increase momentary soil-water availability to the plant. Guaranteeing a high level of water availability in the root zone plays a prerequisite role for productivity in terms of crop quantity and quality. Different substitute measurement methods have been used to manage irrigation. Soil water content, θ, is a central state variable that influences hydraulic properties of soil, which are to be found already when mathematical models are used to quantify water flow and nutrients transport in the soil. The direct acquisition of moisture content in soil has been a difficult task until the effect of the dielectric properties of soil constituents became ascertainable for the propagation speed of electromagnetic waves. Time Domain Reflectometry (TDR) enables to measure transient variation of moisture content. It enables to improve a determination of water dynamics in cropped soils during and between irrigation events (depletion rates at different depths, plant water uptake etc.). The number of potential simultaneous spots to be measured by TDR is limited. To cover broad areas stationary measurement setup is unaffordable and technically problematic. A dynamic sensor that is based on the TRIME technology (IMKO) has recently been developed. The sensor is designed to define the spatial distribution of water content in shallow top soil layers (h=3 cm). The system works with a high temporal resolution of 1 Hz. In order to acquire information about the moisture content of the relevant root zone, a current research approach intends to combine a second measurement system that is based on a modified active microwave sensor to provide the average water content for 30 cm penetration depth. The sensor fusion is promising, thus moisture content variation can be detected at high resolution and accuracy over large areas. Consequently the dynamics of moisture content in the root zone will become quotable over plot and field scale. Such information will be used for an interactive design of autonomous irrigation management in order to improve general and plant-related water use efficiency.

Keywords: Fluent, Irrigation, Site Specific, Soil Moisture, TDR, TRIME, Water Use

Contact Address: Cornelius Jantschke, University of Hohenheim, Institute of Agricultural Engineering, Process Engineering in Plant Production, Garbenstraße 9, 70593 Stuttgart, Germany, e-mail: cornelius.jantschke@uni-hohenheim.de

Development of a Low-cost Tensiometer Driven Irrigation Control Unit for Fruit Tree Irrigation

SATID PINMANEE[1], WOLFRAM SPREER[2], JOACHIM MÜLLER[2]
[1]*Thai-Vietnamese-German Collaborative Research Program, Thailand*
[2]*University of Hohenheim, Agricultural Engineering, Germany*

Irrigated fruit tree production is an important source of income for upland farmers in northern Thailand. As water is an increasingly scarce resource in the hillsides, strategies for more efficient water use are fundamental for sustainably increasing agricultural production and ensuring farmers' livelihoods. However, modern technology for an improved irrigation is often not affordable to upland farmers. Therefore, an adapted solution for optimised irrigation was investigated.
An automatic tensio control (ATC) unit was developed to use soil water tension to open and close the inlet valve of a micro-irrigation lateral. It works without electric components, so that it can be operated in areas without access to electricity. Furthermore, it is assembled from cheap, locally available materials. Thus, it can be easily copied and adapted to different agro-ecological, as well a socio-economic environments.
The ATC was tested under controlled conditions, whereby soil water tension and the opening and closing times of the main valves were recorded. Additionally, soil water content was measured by use of time domain reflectometry (TDR). To monitor the functioning of the ATC under field conditions, three units were set up on commercial orchards in Mae Sa Mai, close to Chiang Mai. The operation was left to farmers, who participated in the evaluation of the device.
Testing the ATC on station and under field conditions, it has proven its reliability in maintaining a favourable moisture regime in the soil. Thereby an optimal water supply of the trees was obtained, avoiding over irrigation. For farmers, however, the complete automatic functioning of the device was considered to be the most favourable aspect.

Keywords: Adapted technology, automatic irrigation, soil moisture, soil water tension

Contact Address: Wolfram Spreer, University of Hohenheim, Agricultural Engineering, 70593 Stuttgart, Germany, e-mail: Wolfram.Spreer@gmx.net

A New Opto-electronic Sensor for Soil Humidity Measurement — Evaluation by Numerical Modelling with Hydrus 2D Software

VITHANAGE PRIMALI ANURUDDHIKA WEERASINGHE, HELMUT SINN, SIEGFRIED KLEISINGER

University of Hohenheim, Agricultural Engineering, Germany

Water is becoming a very scarce resource with the increasing population all over the world. Since 75 % of the fresh water is used for agriculture purposes, improving efficiency is essential in irrigation to address global water scarcity. Water can be used more efficiently by using new technology. Precise soil moisture measurement plays a major role in high efficiency water use. There are a lot of sophisticated soil moisture sensors which are directed towards well-resourced farmers. But, the majority of the world's farmers are the resource poor smallholders who have not been able to afford that sophisticated irrigation technologies. This paper is to introduce a new low cost near infra red sensor with a special moisture conductive cladding material. Numerical modelling is a fast and inexpensive approach to evaluating the moisture movement in the soil-sensor system. A prerequisite for the accurate soil moisture flux modelling is precise parameterisation of soil and cladding material hydraulic functions. Bimodal Van Genuchtan parameterisation of Durner model was used to get hydraulic parameters of the special cladding material. Available hydraulic parameters of the soil were used for the model. There is a possibility to change the environmental and soil characteristics according to weather or climate of the place where sensors are supposed to be installed. Simulated results show a very good relationship with hydraulic characteristics of the cladding material and the soil during a definite range of matrix potential. Experimental observations show good correspondence to the simulation results in modelling. The suitability of the Hydrus 2D software for evaluation of soil-sensor relationship will be discussed.

Keywords: Modelling, near infra red, opto-electronic sensor, soil moisture

Contact Address: Vithanage Primali Anuruddhika Weerasinghe, University of Hohenheim, Agricultural Engineering, Garbenstrasse 9, 70599 Stuttgart, Germany, e-mail: primali@uni-hohenheim.de

Design and Construction of A Solar Dryer for Mango Slices

EL-AMIN AKOY[1], MOHAMED ISMAIL[2], EL-FADIL AHMED[3], WOLFGANG LUECKE[4]

[1]*University of Zalingei, Department of Agricultural Engineering, Sudan*

[2]*University of Khartoum, Department of Agricultural Engineering, Sudan*

[3]*Ministry of Science and Technology, Energy Research Institute, Sudan*

[4]*University of Göttingen, Institute of Agricultural Engineering, Germany*

Based on preliminary investigations under controlled conditions of drying experiments, a natural convection solar dryer was designed and constructed to dry mango slices. This paper describes the design considerations followed and presents the results of calculations of design parameters. A minimum of 16.8m^2 solar collector area is required to dry a batch of 100 kg sliced mango (195.2 kg fresh mango at 51.22 % pulp) in 20 hours (two days drying period). The initial and final moisture content considered were 81.4 % and 10 % wet basis, respectively. The average ambient conditions are 30ºC air temperature and 15 % relative humidity with daily global solar radiation incident on horizontal surface of about 20 MJ/m2/day. The weather conditions considered are of Khartoum, Sudan. A prototype of the dryer was so designed and constructed that has a maximum collector area of 1.03m^2. This prototype dryer will be used in experimental drying tests under various loading conditions. The constructed solar dryer was used to dry thin layer of mango slices, variety Kitchner from about 81.2 % moisture content (wet basis) to 15.6%(wet basis) in 8 hours. Thin layer solar drying experiments were conducted for mango slices (*Mangifera indica* L) variety Kitchner at 3mm slice thickness. Three different mathematical models available in literature namely, Lewis, Henderson & Pabis and Page models were used to evaluate the best fit of experimental data. The best fit of the thin layer solar drying of mango slices was obtained by Page‘s model which fitted very well the experimental data with high value of R^2 (0.98) and low value of χ^2 , SSE and MSBE. According to the results, Page model could satisfactorily describe drying curve of mango slices.

Keywords: Construction, design, drying constant, mango slices, modelling, solar dryer

Contact Address: Wolfgang Luecke, University of Göttingen, Institute of Agricultural Engineering, Göttingen, Germany, e-mail: luecke1@gwdg.de

Single-layer Drying Model for Longan (*Dimocarpus longan* Lour.)

PHUPAICHITKUN SARAWUT[1], BUSARAKORN MAHAYOTHEE[2], METHINEE HEAWSUNGCHARERN[3], SERM JANJAI[4], JOACHIM MÜLLER[1]

[1]*University of Hohenheim, Agricultural Engineering, Germany*

[2]*Silpakorn University, Department of Food Technology, Thailand*

[3]*Chiang Mai University, Faculty of Agro-Industry, Thailand*

[4]*Silpakorn University, Department of Physics, Thailand*

Dried longan, using deep-bed dryer, is an important product in Thailand since 2000. To prevent the non-uniform product, information about moisture content of the product of each layer during drying are important. The modelling of this dryer is not reached due to the complexity of drying single fruit and single layer model. Semi-empirical and empirical models of single layers were used for simulation of the single layer inside the bulk dryer. In this work, based on standard of ASABE, 15 single-layer models were used on nonlinear fitting programming on MATLAB. The coefficient of each model was calculated by fitting with drying curve of drying experiment at different drying conditions. Effect of size of fruit and also temperature, air velocity and relative humidity of drying air to coefficient was studied. The evaluated index of model was defined in term of Residue Sum of Square (RSS), Standard Error of Estimation (SEE) and R^2. As results of all models showed highly fitting with experiment data, RSS is the best index for evaluate model because this index give the different result of each model while this was not found in SEE and R^2 index. For the reason of low coefficients that show low RSS index, Modified Page's model is the simplest model for modelling the moisture content of each single layer in the bulk of longan. There are no effect of air velocity and relative humidity to drying curve and coefficient of each model but these has correlation with temperature and size of fruit. The model with coefficients that are a function of temperature and the size of fruit are widely use in the industries.

Keywords: Drying, fruit, longan, model

Contact Address: Phupaichitkun Sarawut, University of Hohenheim, Agricultural Engineering, Graben Str.9, 70599 Stuttgart, Germany, e-mail: sarawut@ats.uni-hohenheim.de

Thermal Disinfestation of Stored Grain Using Solar Energy

MAHASIN HASSAN MOHAMED ALI AHMED, WOLFGANG LÜCKE, DIETER VON HÖRSTEN

University of Göttingen, Department of Crop Science, Agricultural Engineering, Germany

Food grains are a major dietary source for humans. During storage, grains are seriously affected by many factors, which cause deterioration and losses. Most losses result from infestation by biological agents, mainly insects, which are more active under tropical conditions. Losses as high as 50 % have been reported in many tropical countries. The most common control method is chemical insecticides, but serious problem have been identified their future. High temperature treatment is one of the promising alternatives. It is safe, effective and highly accepted in the market, but it has been seriously constrained by its high-energy requirement. Solar energy has the potential as alternative source of energy because it is free, abundant, and environmental friendly. This study aimed to reduce using non-sustainable energies and eliminate insecticides using, therefore, protecting environment and preserving grains in a good condition for prolonged time.

Experiment was carried out at the Department of Crop Science, Agricultural Engineering Goettingen University, Germany. Thermal disinfestation apparatus was designed to heat grain a continuous-flow system. A solar collector, (3×0.25 m), was constructed from black-painted stainless steel as absorbing material, glass cover, polystyrene for bottom insulation and wood as side insulation and frame. Grain wheat, 10 % moisture content was used in the experiment. System was running under direct solar radiation. Grain, collector and ambient temperatures and solar radiation were recorded. Possibility of obtaining insect lethal temperature 60°C, using different grain flow-rates, was examined.

Results explained that, using solar energy, lethal temperature for all stored-grain insects, could be obtained using different grain flow-rates. Grain flow-rate was found to be in the range of 13.33–30.67 $^{kg}/_{h}.m^2$ of absorber surface area, according to solar radiation quantity. Maximum solar radiation recorded was 850 $^{W}/_{m^2}$. The system can work for 5 $^{h}/_{day}$ under German weather conditions.

With these results it is possible to construct solar driven thermal disinfestation apparatus for grain flow in a continuous-flow system. Results seem to be promising in tropics and subtropics where much solar radiation is available.

Keywords: Solar energy, stored grain, thermal disinfestation

Contact Address: Mahasin Hassan Mohamed Ali Ahmed, University of Göttingen, Department of Crop Science, Agricultural Engineering, Gutenbergstraße 33, 37075 Göttingen, Germany, e-mail: shwok@yahoo.com

Development of a Double Action - Self Fed Cassava Peeling Machine

OLAWALE JOHN OLUKUNLE
Federal University of Technology, Department of Agricultural Engineering, Nigeria

The federal government in Nigeria opened up the market and challenges of cassava production, processing and export in 2004, since then there has been the need to improve the concept and methods of production/processing of cassava. One of the major challenges of cassava processing is peeling. Engineers at the Federal University of Technology, Akure, Nigeria, initiated a major research effort to address this challenge, the effort resulted in the design of two models of a hand fed cassava peeling machine. Feedbacks from users and the public resulted in the development of a self-fed cassava peeling machine. Three models of the latter have been developed and reported. In this study an appraisal of the prospects and limitations of the previous designs is presented. The result of the appraisal was used as the basis for the design of yet an improved version of the self fed cassava peeling machine. The machine consists of a 7Hp Honda engine, two lines of abrasive brush, two lines of auger arranged in parallel, transmission system, frame and tuber monitor. Further improvement was done on the existing models of the self-fed cassava-peeling machine. Major area of improvement include, increase in the length of the peeling brush from 30 cm to 60 cm and automatic adjuster for a range of cassava tuber sizes. A double action self-fed cassava peeling machine was developed and tested under various crop, machine and operational conditions. The effect of brush type, speed and orientation on efficiency of the peeling process was determined. Tubers were presented as cuttings of 20 to 25 cm long and at three different ranges of diameters as < 8 cm, 8–10 cm and > 10 cm. Results show that auger speed of 250 to 1000 rpm resulted in peeling efficiencies of between 82 to 92 % at various peripheral speeds of the peeling brush. Adoption of this peeler is expected to **(i)** promote timely processing of fresh tubers **(ii)** reduce labour input and **(iii)** increase production and hence the income of local processors.

Keywords: Cassava Peeling Machine , double Action, Self-Fed

Contact Address: Olawale John Olukunle, Federal University of Technology, Department of Agricultural Engineering, Praise Close, Peace Avenue FUTA South Gate, 0234 Akure, Nigeria, e-mail: wale_olukunle@yahoo.com

Selection of Packaging Materials for Soybean Seed Storage

SULEEPORN CHUANSIN[1], SUCHADA VEARASILP[1], SOMBAT SRICHUWONG[1], ELKE PAWELZIK[2]

[1]*Chiangmai University, Department of Agronomy, Thailand*

[2]*Georg-August-University Göttingen, Institute of Agricultural Chemistry, Germany*

Soybean seeds var. CM. 60 has been processed and dried to 9.06 percent moisture content. Seeds were stored in 4 different kinds of plastic bag i.e. Metallized film, Aluminum foil, Polypropylene, and Woven Polypropylene for a period of 4 months under controlled temperature (16°C) and relative humidity (65 %). The experimental design was arranged in Factorial in RCB consisting of 2 factors; storage period and packaging material. Changes in fungal flora, water activity value, Carbon dioxide and Oxygen level, standard germination and vigour by accelerated aging technique, electrical conductivity test and acidity value were monthly determined, it was found that seed moisture content was increased in time and showed positive correlation with water activity value and negative correlation with seed germination and seed vigour showed in terms of low percentage standard germination, the electrical conductivity from seed exudates. Oxygen level showed positive correlation with free fatty acid value and showed positive correlation with storage fungi: *Aspergillus sp.*, *A. flavus*, *A. glaucus*, *A. niger*, *A. terreus* and *Penicillium sp.* While field fungi: *Cercospora kikuchii*, *Curvularia lunata*, *Fusarium spp.* and *Macrophomina phaseolina* were decreased. From this experiment, soybean seeds were stored in Metallized film bags and Aluminum foil bags observed highly standard germination and seed vigour, and keep water activity and seed moisture content in low level could delay seed quality deterioration followed by Polypropylene bags and woven bag.

Keywords: Packaing material, seed germination, seed vigour, soybean seed, storage period

Contact Address: Suchada Vearasilp, Chiang Mai University, Department of Agronomy, Chiang Mai, Thailand, e-mail: suchada@chiangmai.ac.th

Inactivation of Cereal Mycotoxines to Gain Income Security Over Biogas Production

BETTINA FRAUZ[1], ULRIKA WEINMANN[2], HANS OECHSNER[1]

[1]*University of Hohenheim, State Institute of Farm Machinery and Farm Structures, Germany*

[2]*University of Hohenheim, Institute for Animal Nutrition, Germany*

As the Food and Agricultural Organisation of the United Nations (FAO) classified 25 % of the world's crops contaminated with Fusarium and its intermediate catabolic products (FAOstat, 2005), cereal production is facing severe yield losses through mould infections. One of the dominating toxins produced by an indigenous population of moulds is Deoxynivalenol (DON). It is know to provoke harmful anorexia and emesis caused by short- or long-term administration to living beings. This forms a hazardous situation for nutrition safety. Due to the known negative impacts of toxins produced, the most feasible, environmentally compatible and economical option has to be found to detach contaminates off the human food chain. A substitutional generation of income is imperative, to secure farmers income. Current research at Hohenheim's State Institute of Farm Machinery and Farm Structures focus on a potential deactivation of mycotoxines by biogas fermentation processes. A set of novel routines have been run in test series. The parameter variation of temperature, infection rate and time of exposure in a bench-scale set-up was used to evaluate chances of a toxine deactivation and a simultaneous production of biogas. First findings of the running cooperative project under foundation of the German FNR prove the inactivation potential of biogas fermentation to either *Fusarium* (CFU), DON or DOM^{-1}. Retention times of 0.5 days showed no evidence of Fusarium spores after extraction and examination. A simultaneous and suitable production of biogas underlines the realistic economic potential of this approach in the course of practical retention times and conditions of a fermentation process. Thus food security is potential to be gained over income production.

Keywords: Anaerobic Fermentation, Biogas, Energy Production, Fusarium, Inactivation, Mycotoxine

Contact Address: Bettina Frauz, University of Hohenheim, State Institute of Farm Machinery and Farm Structures, Garbenstrasse 9, 70599 Stuttgart, Germany, e-mail: b-frauz@uni-hohenheim.de

Biodiversity

Coping with Climate Change and the Role of Agrobiodiversity

JOHANNES KOTSCHI
AGRECOL - Association for AgriCulture & Ecology, Germany

The world's biological diversity is eroding. This concerns in particular the entire agricultural diversity of genes, species and their agrarian ecosystems, thus the resource base for food. With species becoming extinct, mankind is jeopardised. In this process, the effects of climate change become increasingly important. The most relevant climate change-related factors to agriculture are: the rise in temperature, reduced water supply and increased UV radiation. Severe implications are expected for agriculture and food supply notably in sub-tropical regions. As a consequence, a two-pronged strategy is required: mitigation of and adaptation to climate change. Agrobiodiversity plays a key role in this, which calls for a revision of the present conservation approaches. Instead of ex-situ conservation in gene banks a broader concept has to be envisaged by which emphasis is on in-situ conservation complemented by gene banks. The reason is twofold: **(1)** as future needs are unknown, a maximum of genetic resources has to be conserved at the lowest possible public cost. On-farm conservation is not necessarily less costly, but the costs are mainly borne by farmers and it produces private and public benefits **(2)** adaptation of genetic resources to environmental change is a necessary process that requires exposure to the environment, rather than deep-freeze storage in a gene bank.
So far, there is little awareness among professionals of the close relationship between climate change and food security and the role agrobiodiversity has to play. It is imperative to manage agrobiodiversity in a sustainable way. Climate change-induced environmental stress may in fact go beyond the reach of adaptation. But the in-situ approach offers a great chance to shape a future worth living.

Keywords: Conservation strategies, in-situ conservation, stress adaptation

Contact Address: Johannes Kotschi, AGRECOL - Association for AgriCulture & Ecology, Johannes Acker Straße 6, 35041 Marburg, Germany, e-mail: kotschi@agrecol.de

A Preliminary Study on Indicator System of Natural Rubber Security in China

YOUPENG KE[1,2], JIANCHUN GUO[2,3], TAN JIHU[3]

[1]*Chinese Academy of Tropical Agriculture, Rubber Reseach Institution, China*

[2]*South China University of Tropical Agriculture, Economics and Managment College, China*

[3]*South China University of Tropical Agriculture, Tropical Agricultural Development Research Institute, China*

Natural rubber, a kind of world bulk industrial raw material and one of four important industrial raw materials, is scarce, short and strategic resource indispensable for national defense and industrial construction. Recent international gross demand for natural rubber has been steadily rising; international export resource of natural rubber has been decreasing annually.

The occupied rate of consumption of natural rubber in China has raised from 7.43 % in 1981 to 19.56 % in 2004, the growth range has reached as high as 163.26%; The share of China's natural rubber product in the world is 3.40 % in 1981 up to 6.68 % in 2005, which has increased 96.47%; The import share in the world has increased from 6.80 % in 1981 to 20.63 % in 2005, the percent of growth is up to 208.83 %. domestic gap between supply and demand has inclined to enlarge and self-sufficiency rate has been unremittingly falling, in addition to the right to participate in rules of international rubber production, price, market and so on has been gradually marginalised, which extremely threatens China, whose present producing scale is only fifth in the world market, while consumption and import is first and its self-sufficiency is below 30 %.

For all these reasons, the purpose of the study is to design an indicator system of natural rubber security based on the analysis of influencing factors of China's natural rubber production, consumption and import, the status in the world natural rubber market and etc.. On the basis of the above analysis, the paper mainly explores the definition content of the indicator system of natural security, and discusses the methods to calculate the security indicators, furthermore to discuss the criterion of the security indicators.

Keywords: China, indicator system, natural rubber, security

Contact Address: Youpeng Ke, Chinese Academy of Tropical Agriculture, Rubber Reseach Institution, China, e-mail: ypke92@hotmail.com

Ecophysiological Diversity of Wild *Coffea Arabica* Populations in Ethiopia — Implications for A Succesfull Conservation Strategy

ALICE BEINING, JÜRGEN BURKHARDT

University of Bonn, Institute of Crop Science and Resource Conservation - Plant Nutrition, Germany

Drought is a serious constraint on the productivity of *Coffea arabica* in many countries worldwide that prevents the cultivars from expressing their full genetic potential. Hence, the development of drought resistant plants is considered a promising strategy to ensure economic production when resources are limited. However, early domestication and modern plant breeding severely eroded genetic variations of modern cultivars compared with their wild progenitors, making crop plants increasingly susceptible to environmental stresses. Consequently, wild populations of *Coffea arabica* that can be found in the Ethiopian Afromontane rainforests constitute the last remaining genetic reserves of great value for the producing and consuming world. Despite its importance however, natural stands of wild coffee are diminishing at alarming rate mainly due to deforestation activities. Thus, there is an urgent need to assess the ecophysiological diversity and to identify suitable sites for conservation activities in order to maintain the irreplaceable genetic resources of *Coffea arabica* found in Ethiopia.

The study focuses on distant wild populations of *Coffea arabica* in Ethiopia that are widely distributed over an area with high heterogeneity in water availability. It is hypothesised that this gradient promotes different selection pressure for traits related to water use. Differences in gas exchange, carbon isotope discrimination and leaf water relations were studied in their natural habitat as well as under controlled environmental conditions in order to determine whether climate-driven shifts in physiological traits between distant populations of *Coffea arabica* are caused by phenotypic plasticity or represent ecotypic differences.

The results of the *in situ* study indicate that there is a high variability in water use strategies among the populations and that they are well-adapted to their local environment. When grown under identical environmental conditions (ex situ), populations still maintain differences in their ecophysiological behaviour. However, their adaptive differences in physiology do not reflect the water availability of the site of origin. This has major implications for the conservation strategy of the threatened wild coffee populations and *in situ* conservation should be seen as the most important instrument in order to maintain the ecophysiological diversity found in the wild populations of *Coffea arabica* in Ethiopia.

Keywords: Drought, ecophysiological diversity, *in situ* conservation, rainfall gradient

Contact Address: Alice Beining, University of Bonn, Institute of Crop Science and Resource Conservation - Plant Nutrition, Karlrobert-Kreiten-Straße 13, 53115 Bonn, Germany, e-mail: abeining@uni-bonn.de

Camu-camu: a Promising Fruit from the Amazon Basin

ROBERTA B. RODRIGUES[1], MENELAOS PAPAGIANNOPOULOS[1], JOSÉ GUILHERME S. MAIA[2], KAORU YUYAMA[3], FRIEDHELM MARX[1]

[1]*University of Bonn, Institute of Nutrition and Food Sciences, Germany*
[2]*Federal University of Para, Food Chemistry, Brazil*
[3]*Instituto Nacional de Pesquisa da Amazonia(INPA), Brazil*

The Amazon forest contains a great number of fruit bearing species in the wild state, with a small part being explored by harvesting from the wild or subsistence agriculture. This group includes the camu camu (*Myrciaria dubia*), family Myrtaceae. The most distinctive feature of the camu camu fruit attracting attention is its extremely high content of vitamin C (1000 to 3000 mg/100 g in the pulp). The harvest of camu camu fruit in naturally occurring stands is difficult - at harvest time the shrubs are usually partially flooded. Recently, growing trials on non-flooded soils are promising. In the harvest regions, the fruit is consumed in the form of juice, ice-cream, fruit purees and jams, not being consumed in its natural state due to its high acidity. More recently there has been an increasing demand for camu camu pulp in the larger commercial centres of Brazil for the production of healthy beverages. Compounds like ascorbic acid and anthocyanins, present in the camu camu, are known to act as dietary antioxidants. They are reactive oxygen species scavengers, which can play an important role in the prevention of illnesses like cancer or cardiovascular diseases or to slow down the ageing process. For a better understanding of the health benefits from the camu camu fruit, we have determined the antioxidant capacity of the fruit with the Total Oxidant Scavenging Capacity assay. This assay is based upon the ethylene yielding reaction of α-keto-γ-methiolbutyric acid with three different reactive oxygen species (ROS). The time course of ethylene production was monitored during one hour by repeated headspace GC. In comparison with other fruit, camu camu presents outstanding antioxidant features. Not only the extremely high content of ascorbic acid but also compounds likes anthocyanins or flavonolglycosides seem to contribute to the overall antioxidant capacity of camu camu fruit pulp. The camu camu is, until now, a hardly known fruit that presents a high potential to be explored as a functional food not only in the Amazon region but also in the big markets of Europe and the USA.

Keywords: Antioxidant capacity, camu-camu, *Myrciaria dubia*, TOSC assay, Vitamin C

Contact Address: Friedhelm Marx, University of Bonn, Institute of Nutrition and Food Sciences, Endenicher Allee 11-13, 53115 Bonn, Germany, e-mail: f.marx@uni-bonn.de

Floral Biology of *Cratylia argentea* — First Results of a Study in Colombia

MARIA BYSTRICKY[1], MICHAEL PETERS[2], GERMAN ESCOBAR[2], RAINER SCHULTZE-KRAFT[1], LUIS H. FRANCO[2]

[1]*University of Hohenheim, Institute for Plant Production and Agroecology in the Tropics and Subtropics, Germany*

[2]*International Centre for Tropical Agriculture (CIAT), Colombia*

Cratylia argentea is a forage legume shrub well adapted to infertile, acid soils. In combination with its high drought tolerance and nutritive value, this renders the plant particularly useful for the subhumid tropics, where it grows best below 1200masl.

A lack of knowledge of the species' reproductive system makes germplasm management difficult. Apparently there is a certain outcrossing rate as indicated by high genetic variability within accessions as well as abundant visits of insects. Our objective is to verify the dependence of reproduction on insect visits. There are tree possibilities: **(a)** The visiting insects produce self-pollination through tripping, causing pollen transfer between anthers and stigma of the same flower; **(b)** the insects serve as pollen vectors thus producing cross-pollination; **(c)** a mixed mating system, which is most likely.

We defined three floral phases: 1. Closed bud: Anthers open the day before anthesis. 2. Anthesis: flowers open in the morning and close in the afternoon, the pollen being mature only for a short time while the stigma is always receptive. 3. Withering: Flowers close and remain so for some days before either the whole flower or the petals drop, then leaving behind the ovary. Generally the percentage of pod set is very low (4–7 % in non-manipulated, non-isolated flowers).

Current studies aim at the assessment of pod set and number of seeds per pod after the following treatments: natural self-pollination (labeling non-manipulated isolated flowers); artificial self-pollination (manual tripping of isolated flowers); natural cross-pollination (labeling flowers visited by insects); and artificial cross-pollination (after emasculation of flower buds). Furthermore, the main insects visiting *C. argentea* flowers are being identified, and pollen dispersal by insects is being studied by marking flowers with fluorescent powder.

As environmental conditions may affect the floral biology of *C. argentea*, results of this study should be validated at other sites to assess the impact of site properties on reproductive system and pod set.

Keywords: floral biology, forage legumes, reproductive system

Contact Address: Rainer Schultze-Kraft, University of Hohenheim, Department of Biodiversity and Land Rehabilitation, Garbenstraße 13, 70593 Stuttgart, Germany, e-mail: rsk@uni-hohenheim.de

Diversity Assessment of the Tropical Legumes Genus *Stylosanthes*: A Research Project in Venezuela

TEODARDO CALLES[1], RAINER SCHULTZE-KRAFT[1], ORLANDO GUENNI[2]

[1]*University of Hohenheim, Biodiversity and Land Rehabilitation in the Tropics and Subtropics, Germany*

[2]*Central University of Venezuela (UCV), Agricultural Botany, Venezuela*

The genus *Stylosanthes* is probably the most important genus for purposes other than grain production (e.g. forage, soil cover, soil improvement). Currently, some species have a particular importance for low-input agro-ecosystems in Australia, Africa, Southeast Asia, India and China. In previous research, germplasm and herbarium surveys were conducted in Venezuela and a comprehensive taxonomic and biogeographic database was obtained. It helped to better understand the natural distribution of the genus and identify collection gaps regarding both species and regions of particular interest. Based on the herbarium survey, three distinct groups of odd specimens were identified. With this information, a trip was organised to the respective origin regions to collect herbarium specimens, seeds and inflorescences. Examination of the collected material showed, that the three odd groups represent two as yet undescribed species ("*Stylosanthes venezolensis*" and "*Stylosanthes falconensis*") and one new botanical variety of *Stylosanthes viscosa* from high altitudes (above 2500 m asl). One of the conclusions of the survey was that some Venezuelan *Stylosanthes* species have multiple adaptations and can be found in a quite broad range of environments; therefore, quite distinct ecotypes are likely to occur. Since ecological conditions alone may not be sufficient to classify populations as distinct ecotypes, in-depth genetic studies are required to determine whether populations from contrasting environments are actually genetically so diverse that they can be classified as ecotypes. To properly assess the natural, inter- and intra-specific diversity of *Stylosanthes* species, future research in Venezuela will concentrate on the variability occurring in the wild. For this, germplasm collecting missions will be conducted to regions covering environmental ranges of particular interest. Then, the collected germplasm will be used for molecular analysis of genetic diversity, applying the Random Amplification of Polymorphic DNA (RAPD) technique. As a result, we will be able to identify not only inter- and intra-specific *Stylosanthes* variations but also to map the occurrence of such genetic diversity in Venezuela. The information obtained will help breeders and biodiversity managers to design further collecting and conservation strategies.

Keywords: Diversity, genetic, RAPD, Stylosanthes, Venezuela

Contact Address: Teodardo Calles, University of Hohenheim, Biodiversity and Land Rehabilitation in the Tropics and Subtropics, Garbenstraße 13, 70599 Stuttgart, Germany, e-mail: callest@uni-hohenheim.de

Field Characterisation of a Collection of the Forage Tree Legumes *Leucaena diversifolia* and *L. trichandra* — an Ongoing Project in Colombia

KATRIN ZÖFEL[1], RAINER SCHULTZE-KRAFT[1], MICHAEL PETERS[2], LUIS H. FRANCO[3]

[1]*University of Hohenheim, Department of Biodiversity and Land Rehabilitation, Germany*

[2]*International Centre for Tropical Agriculture (CIAT), Colombia*

Previous research has shown that *Leucaena diversifolia* and the closely related *L. trichandra* can be considered as promising tree legumes: Because of their adaptation to acid/infertile soils and to higher altitudes (<2000 masl), they offer an alternative to the wellknown and widely used multipurpose tree *L. leucocephala* which doesn't thrive under such conditions. The evaluation of *L. diversifolia* and *L. trichandra* was hitherto restricted to only few accessions.

The study is based on the world collection available in 2005 (50 accessions of *L. diversifolia* and 11 of *L. trichandra*), established on an acid, low-fertility Ultisol at the CIAT-Quilichao experiment station (1000 masl) in Colombia. The objective is to assess differences in morphological, agronomic and nutritive-value characteristics both between species and among accessions.

The study is still ongoing but data available now indicate good to very good vigour of all accessions, and absence of pests and diseases. Four months after transplanting seedlings to the field, plant height and width were up to 2.3 m and 2.4 m, respectively. Growth habit ranges from erect to ascendent, with large differences in number of branches below 0.5 m, the usual cutting height for forage shrubs; hence differing regrowth capacity can be expected. Morphological features like length and width of leaves and pinnules vary greatly among accessions as do pinnule pubescence and colour of pinnule margins. Since texture of leaves differs greatly (from soft to rather coriaceous, and from hairy to glabrous), differences in acceptance by grazing livestock are likely to occur. The main morphological differences between the two species are length and width of pinnules (4.0–8.0mm respectively 0.8–1.4mm for *L. diversifolia*, and 5.2–12.6mm respectively 1.6–3.2mm for *L. trichandra*), and numbers of pinnae per leaf and pinnules per pinna, both being distinctly lower for *L. trichandra*.

Ongoing evaluations include nutritive value, yield and regrowth capacity, especially for the dry season. Promising accessions will be selected for regional trials at different elevations (1000–2000 masl) to enable definitive conclusions on species adaptation and productivity in tropical midaltitude hillside situations.

Keywords: Germplasm characterisation, *Leucaena diversifolia*, *Leucaena trichandra*, tropical tree legumes

Contact Address: Katrin Zöfel, University of Hohenheim, Department of Biodiversity and Land Rehabilitation, 70593 Stuttgart, Germany, e-mail: k.zoefel@gmx.de

Evaluation of Heterosis in Durum Wheat (*Triticum durum* Desf.)

ELFADL ELFADL[1], CHRISTOF KLING[2], ALBRECHT MELCHINGER[2]

[1]*University of Hohenheim, Crop Production Institute, Germany*
[2]*University of Hohenheim, State Plant Breeding Institute, Germany*

Development of hybrid durum wheat rests on the premise that there is heterosis in this crop. In deciding whether or not hybrids are producible, information is needed not only on the magnitude of heterosis but also on the types of gene action and their relative importance in the inheritance of all agronomic and quality traits. Unfortunately, there is no relevant durum-specific data available on the achievable heterosis level in F1 hybrids and their yield stability relative to pure lines in any environment. The main objectives of this study were: I. Evaluation of magnitude of heterosis in hybrid between durum wheat lines derived from two diverse germplasm pools. II. Identification of the nature of gene action controlling the inheritance of the investigated traits. Ten diverse parental lines, five German lines and five CIMMYT lines; were crossed following an incomplete diallel mating scheme to produce 45 F1 hybrids. The parents and their F1 hybrids were planted at Obregon, CIMMYT experimental station, in a replicated lattice design. Thirteen agronomic traits were investigated for the amount of heterosis, predominant gene action and for phenotypic correlation. Significant positive heterosis was observed in many traits. The superiority of inter-pool hybrids over intra-pool hybrids with respect to mean performance and heterosis for grain yield and other traits was observed in this study. However, the heterotic expression revealed by these hybrids was highly affected by unusual growing conditions, particularly the high temperature during grain filling period, and lack of adaptation of German lines to these conditions. It has been generally observed that hybrids between unadapted parents, exhibit more heterosis than hybrids between adapted ones. Heterosis for grain yield could be attributed to the yield components grains/spike, grains/spikelet and thousand grain weight. Both additive and non additive gene actions played a role in the inheritance of the investigated traits, however, additive gene action was predominant. None of the parents could be identified as a good general combiner for all traits studied, none the less, various best combiners for the most relevant characteristics were found.

Keywords: Additive gene action, durum wheat, Heterosis, Hybrid, Non additive gene action

Contact Address: Elfadl Elfadl, University of Hohenheim, Crop Production Institute, Schwerzstr. 2/702, 70599 Stuttgart, Germany, e-mail: elmogtaba@yahoo.com

Marker Assisted Heterotic Grouping of Sudanese Landraces

TAHANI ELAGIB, HEIKO PARZIES, HARTWIG GEIGER
University of Hohenheim, Population Genetics, Germany

Sorghum [*Sorghum bicolor* (L.) Monech] is the most important grain crop in the Sudanese economy and diet. In Sudan sorghum ranks first in terms of cultivated area (6 million hectares) and production (2.6 million metric tons) (FAO, 2005). However, yield per unit area is very low (250 kg/ha) in comparison to the world average (1390 kg/ha).The aim of this study therefore is to characterise the pattern of molecular genetic diversity in a representative samples of Sudanese sorghum landraces and to determine genetically distinct pools which shall serve as base materials for hybrid breeding.

The pattern of genetic diversity was assessed among 40 sorghum landraces from Sudan along with 27 cultivars from ICRISAT.Thirty-one simple sequence repeat markers (SSRs) were used. Fifteen of them were used as individual primers while the other 16 were combined into sets suitable for triplex PCR loaded on a 3 % metaphor gel.

In total 193 alleles (different fragment sizes) were observed in the Sudanese landraces and in the world collection. The number of alleles per locus ranged from 4 for primer Sb5–256 to 19 for Sb5–206 & Sb6–84 with an average of 12.9 alleles per locus. In the triplex PCR, the number of alleles per locus ranged from 2–8 averaging to 2.8.

A dendogram was constructed from Modified Rogres, Distance (MRD) measures.The accessions clustered into eight major groups. No major clustering by race was observed.

Based on the cluster analysis, 31 landraces and inbred lines were selected for production of testcrosses with 2 cytoplasmic male sterile (ms) lines derived from different gene pools. In addition, diallel crosses among representatives of different clusters were produced. The landraces, inbred lines, and testcrosses were evaluated in regular yield trials at two test sites in Sudan (Wad Medani and Damazin) in 2005 while the diallel crosses (in generation F2) were evaluated at Wad Medani only. The evaluation will be repeated in the 2007 season. Final clustering will be based on both molecular-marker and field data.

Keywords: Sorghum, Diversity

Contact Address: Tahani Elagib, University of Hohenheim, Population Genetics, Fruwirthstr. 21, 70599 Stuttgart, Germany, e-mail: tahani_3@yahoo.com

Decentralised Post-harvest Technologies to Produce Value Added Crops from Neglected Plants

OLIVER HENSEL

University of Kassel, Agricultural Engineering, Germany

Land use systems described by a diverse range of cultivated species can only be successful if farmers have the opportunity to generate additional income from that kind of agriculture. Especially neglected crops, even when being cultivated on small scale areas and/or mixed cropping and rainforestation systems, enable new marketing chances. The poster presents research activities at the Naban River watershed in the Dai Autonomous Prefecture of Xishuangbanna, Yunnan province, Southwest China, where special crops like medicinal plants, herbs, spices and mushrooms where investigated to be alternative products to the farmers. These products need to be processed to achieve marketing- and transportation condition. Therefore simple processing such as drying and smoking (spices, mushrooms) or extraction (medicinal plants) has to be done, which could be performed on farm level, whereas the added value remains in the village. Up to now for these crops there is no substantiated knowledge available about how to optimise the processing parameters (e.g. temperature, duration, preprocessing). In both laboratory and field tests appropriate species are to be identified and optimised processing procedures are to be developed to be able to produce value added and marketable products. In addition there is to be assumed, how far renewable energy sources (e.g. solar dryers and extractors) can be used to increase economic and ecologic benefits. First results were presented from a cooperation project between Kassel University and TianZi Biodiversity Research and Development Centre, located at Jinghong / Southwest China, where spices have been processed by a combined smoking / drying — plant.

Keywords: China, neglected plants, processing

Contact Address: Oliver Hensel, University of Kassel, Agricultural Engineering, Nordbahnhofstr. 1a, 37213 Witzenhausen, Germany, e-mail: agrartechnik@uni-kassel.de

Effects on Plant Species Composition of Glyphosate Application in a Plantain System after Secondary Forest Clearing

STEFAN HAUSER[1], SERAPHIN NGOUMBE[1], BERNARD ALOYS NKONGMENECK[2]

[1] *International Institute of Tropical Agriculture, Humid Forest Eco-regional Center, Cameroon*

[2] *University of Yaounde, Plant Biology, Cameroon*

Weed control is a major challenge in African smallholder agriculture. In long-term crops, particularly those planted at low densities, such as plantain (*Musa spp*. group ABB) weed control is virtually absent and has received little research attention. Plantain is dominantly grown after slash and burn of old secondary forest, where little weed growth occurs in the first year. Declining availability of such land and increasing pressure of invasive weeds requires changing plantain management. Plantain is the most important food cash crop in Cameroon and large parts of the Congo basin. This study evaluates how herbicide use affects the species composition in a plantain field established in young secondary forest.

Plant species were determined in plantain plots and sub-plots were either slashed or treated once or twice with 6l ha^{-1} Round-up®. Species' survival was determined at 10, 20, and 30 days after treatment (DAT). The forest around the site, sampled as a control had 154 species. At 14 months after planting 171 species were identified in plots to be slashed and 182 species in plots to be treated with herbicide. Survival at 30 DAT, following single herbicide application ranged from 13 to 25 %. When treated twice, survival was 32 % ($p < 0.001$ compared to single treatment). Slashing caused the disappearance of 12 species (equivalent to 97 % survival). About 100 DAT, 170 and 139 species were identified in slashed and sprayed plots, respectively, representing 99.4 and 76 % of the initial number of species. When herbicide was used at 17 months after planting, species numbers increased by about 20 % over the following 5 months, when treated once and when treated twice. Weeds were classified by their response to herbicide into highly susceptible: died within 10 DAT, 40 spp., 25–26%; susceptible: died within 10–30 DAT, 53 spp., 32–35%; tolerant: showed symptoms but recovered, 54 spp., 32–35%; resistant: showed no symptoms, 8 spp., 4–6 %. All tolerant and resistant species were members of the forest plant community. No typical cropping phase weed was tolerant or resistant. Glyphosate use may retain species communities similar to those found in forests.

Keywords: Glyphosate, plantain, Round-up, secondary forest, species community, survival, weeds

Contact Address: Stefan Hauser, International Institute of Tropical Agriculture, Humid Forest Eco-regional Center, Cameroon, e-mail: s.hauser@cgiar.org

BIOTA Project

The Governance of Biodiversity: the Case of Kakamega Forest, Western Kenya

JUDY KARIUKI
University of Dortmund, Spatial Planning, Germany

Kenya is endowed with diverse land based natural resources, which contribute directly or indirectly to the socio-economic welfare of its people. Institutions responsible for managing natural resources in Kenya are many and varied. These being the product of a series of legislative measures and administrative decrees promulgated through out the last century. This includes the multiple statutes addressing biodiversity conservation, which are implemented by various organisations that include the sectoral ministries and the civil society. This system encourages duplication of efforts and sometimes counters effects in policy implementation due to lack of proper networking. This has resulted to a competitive, independent approach towards biodiversity management thus evading the holistic approach required for effective biodiversity conservation. The outcome is an un-integrated system with each sector viewing its territory as a platform for its own exclusive activities irrespective of the other players. Biodiversity degradation in Kenya has therefore persisted despite the efforts geared towards its conservation. The challenge is in harmonising the institutional network, that is, the statutes and organisations mandated with biodiversity conservation so that the actor's roles are better defined and linked thus enhancing its conservation. This study examines the effects of the multiple institutions on biodiversity conservation. It further looks into a way forward in harmonising the institutional set-up with the aim of contributing to a less beauracratic and streamlined system that would be better implemented.

The main objectives of this study therefore are to attain institutional order that will enable sustainable conservation and management of biodiversity in Kenya. It is also meant to institutionalise the outcomes of the Biota research project by addressing the proper institutional hierarchy appropriate for the implementation of Participatory Land Use Planning (PLUP) and other approaches recommended for biodiversity conservation and sustainable livelihoods .

Keywords: Biodiversity, governance, institutionalisation, sustainability

Contact Address: Judy Kariuki, University of Dortmund, Spatial Planning, August - Schmidt Str. 10, Dortmund, Germany, e-mail: wambuikar@yahoo.com

Cultural Foundations of Stakeholder Attitudes and Acting - the Case of Forest Management in Kenya

BARBARA TAUBERT, JÜRGEN PRETZSCH

Technische Universität Dresden, Institute of Internationale Forestry and Forest Products, Germany

Human behaviour towards forests is guided by individual perceptions and world views. Prevailing cultural norms and rules find their expression in the variety of different skills and practices that exist within a society in relation to natural resources.
Forests in Western Kenya represent a highly contested resource that is used, exhausted and restored in various ways. Since the pressure on the forests results from high population growth rates and an intensive agricultural land use combined with rural poverty, forest maintenance and rehabilitation require the participation of the rural population. Understanding the cultural meanings, roots and reasons of their forest related behaviours can increase the options for forest protection and sustainable forest management.
The study aims to reveal the socio-cultural foundations of stakeholder perceptions and behaviour towards forests, as well as to identify the origins and underlying sources of cultural impact. Two concepts, the Ordered Adaptive Structure (Bargatzky 1986) and the Level Scheme (Irrgang 2004), provide the theoretical framework of the study. Both concepts serve to reveal the specific visions and sacred ideas that guide local people to use, manage, (over-)exploit and rehabilitate forest resources.
This poster presents the main theoretical underpinnings of the research project, as well as the state of the scientific debate. Findings of a first exploratory study that was carried out at the Kakamega forest and around Mt. Elgon using key informant interviews and other empirical qualitative research methods serve to illustrate the attitudes of selected stakeholders towards forest management, as well as their impact on the forests.

Keywords: Attitudes, cultural impact, forest use, perception, values

Contact Address: Barbara Taubert, Technische Universität Dresden, Institute of Internationale Forestry and Forest Products, Pienner Str.7, 01737 Tharandt, Germany, e-mail: taubert@forst.tu-dresden.de

Economic Valuation of the Benefits of Conserving Kakamega Forest, Kenya

IASON DIAFAS

University of Bonn, Center for Development Research (ZEF), Germany

The main purpose of this study is to measure the magnitude, in monetary terms, of the indirect and non-use benefits associated with the conservation of Kakamega forest, Kenya. This is part of an organised attempt by BIOTA East Africa to estimate the Total Economic Value (TEV) of the forest to the communities residing around the forest. Such an attempt is important in order to demonstrate the economic benefits of conserving the forest and compare them with the opportunity cost of conservation. TEV encompasses direct use values (timber, and non-timber forest products), indirect use values (water regulation, soil erosion prevention, etc.) as well as non-use values (existence value, bequest value).

In order to estimate indirect use values, as well as non-use values, the use of stated preference (SP) techniques was deemed appropriate. This was justified on the grounds that there are very limited data on the ecological services of the forest that would facilitate the use of revealed preference methods. Furthermore, SP methods are better suited to estimate non-use values.

The chosen methods for measuring the values that the local population attaches to the services of the forest are Contingent Valuation (CV) and the Choice Modelling technique (CM). The reason for choosing to employ CM on top of CV is the additional information that will be obtained with regard to the values of specific attributes/services of the forest. The concurrent use of those techniques may also help to test for convergence between the values obtained from each of them, and potentially shed light on the existence or non-existence of systematic differences between these two closely related methods. Following the pretesting of the questionnaire, the survey was administered to 320 respondents in face-to-face interviews. Due to size of the sampling population, the respondents were picked using a stratified random sample.

Keywords: Economic Valuation

Contact Address: Iason Diafas, University of Bonn, Center for Development Research (ZEF), Bonn, Germany, e-mail: idiafas@uni-bonn.de

Local Communities' Dependence on Ntfps in Kakamega Forest: Analysis of Economic Value, and Determinants of Participation and Extraction Levels

STEPHEN MUTIE[1], JOHN MBURU[2], CHRIS ACKELLO-OGUTU[1], PAUL GUTHIGA[2]
[1]*University of Nairobi, Department of Agricultural Economics, Kenya*
[2]*University of Bonn, Centre for Development Research (ZEF), Germany*

The study assesses the types and quantities of direct non-timber forest products (NTFPs) extracted by the local people living around the Kakamega Forest in Western Kenya. It further analyses the factors that influence a household's decision to participate in NTFPs' collection and the level of extraction undertaken. The results of this study are derived from a stratified sample of 370 households who were interviewed with a semi-structured questionnaire. The quantities of the different products obtained by extracting households are valued at the average market prices to obtain their financial values. The results of the study indicate that the forest generates a substantial economic value to the local people. It was found that this value is comparable to that of the common crop enterprises in the research area. A Heckman two- stage regression model is used to analyse the socio-economic, institutional, and geo-physical factors that influence the household decision to participate in forest extraction and the quantities of the different products obtained. Proximity to the forest edge, the form of forest management approach, age and education level of the household head, household private land holding and participation in forest conservation activities are the main factors influencing the household decision to extract NTFPs from the forest. The level of extraction for the participating households is influenced by their proximity to the forest, the household size, participation in forest conservation activities and whether the household uses the extracted forest products as a source of income. The study concludes by highlighting some important policy inferences for sustainable use and conservation of Kakamega Forest.

Keywords: Forest extraction, Gross Margin. , Heckman model, Kakamega Forest, nTFPs

Contact Address: Stephen Mutie, University of Nairobi, Department of Agricultural Economics, Kapenguria Road P.O. Box 29053, Nairobi, Kenya, e-mail: stmutie@yahoo.com

Local Communities' Perceptions Towards Forest Management Regimes: Case of Kakamega Forest in Kenya

PAUL GUTHIGA[1], JOHN MBURU[1], KARIN HOLM-MÜLLER[2]
[1]*University of Bonn, Center for Development Research (ZEF), Germany*
[2]*University of Bonn, Institute for Agricultural Policy, Germany*

Kakamega Forest is located in western Kenya and covers approximately 240 Km^2. The forest is the only lowland tropical rainforest in Kenya and it is world famous for its diversity of unique and numerous flora and fauna. However its survival is under immense threat since it is located in a densely populated area where local communities depend heavily on agriculture and forest extraction for their livelihoods. Currently, the forest is divided into three different parts that are managed through three distinct management approaches: an incentive-based approach of the Forest department (FD), a protectionist approach of the Kenya Wildlife Service (KWS) and a quasi private- approach of a local church mission, the Quakers. A review of literature clearly indicates that forest management regimes of public forests are important in assigning property rights to the various stakeholders and guiding use and consequently the outcomes. On the same footing research has pointed out the centrality of the local communities in the process of natural resource management. The persistence of resource degradation problems and failure of technical simple technical or economic prescription clearly indicates that there is need to consider the more complex aspects of natural resource management. The perception of the local people towards management regimes and the factors that condition their perception is important in designing policies for sustainable use of natural resources. This study considers how the local communities perceive the management regimes in terms of meeting the goal of utilising and conserving forest biodiversity. Satisfaction ranking showed that the strictest regime among the three was ranked highest overall. Coincidentally, the highest ranked regime has the best performance among the three in conserving the forest in its pristine state. An ordered logit regression was used to analyse factors influencing the overall satisfaction ranking. The results indicate that socio-economic factors are not significant in explaining the level of satisfaction ranking but involvement in forest conservation activities appears important in explaining satisfaction ranking. The paper concludes by highlighting some policy implications of the results.

Keywords: Management Regime, Perception, Satisfaction ranking

Contact Address: Paul Guthiga, University of Bonn, Center for Development Research (ZEF), Walter-Flex Str. 3, 53113 Bonn, Germany, e-mail: pguthiga@uni-bonn.de

Land Use Intensity in Western Kenya: Case of Kakamega

ELIZABETH NAMBIRO[1], MATHIAS BECKER[1], KARIN HOLM-MÜLLER[2]
[1]*University of Bonn, Institute of Crop Science and Resource Conservation - Plant Nutrition, Germany*
[2]*University of Bonn, Institute for Agricultural Policy, Germany*

In Kenya, agriculture remains the main occupation and source of income for majority of the population and accounts for about one-third of the gross domestic product and employs more than two-thirds of the labour force. Increasing per capita food production and raising rural incomes are the great challenges facing Kakamega farmers in western Kenya. One way of solving the problem of food shortage in Kakamega is to increase agricultural productivity. Land use intensification is one of the current methods used to increase agriculture productivity in Kakamega. Several hypotheses have postulated market access, population growth, socio economic characteristics and agro ecological zones to have possible effects on land use intensity. Two-stage sampling design was used to select the households. The survey was conducted among 280 households representing a combination of high or low population density, two different agro ecological zones and high or low market access, to test these hypotheses. Using a censored regression model, the result show that agro ecological zone, market access and some socio-economic characteristics of households and their interactions are important drivers of land use intensity in Kakamega. As one moves from low market access to high market access regions; the degree of land use intensity increases. Also as one move from the Lower Midland to Lower Highland agro ecological zones the land use intensity tends to increase. In addition to market access and agro ecological zones, specific socio-economic characteristics of the households also influences land use intensity. This analysis confirmed the hypothesis that market access, agro-ecological zone and socio-economic characteristics are some of the factors that influence land use intensity.

Keywords: Agro-ecological zones, land use intensity, market access

Contact Address: Elizabeth Nambiro, University of Bonn, Institute of Crop Science and Resource Conservation - Plant Nutrition, Karlrobert-Kreiten Str. 13, 53115 Bonn, Germany, e-mail: enambiro@yahoo.com

Dynamics of Resource and Labour Allocation in Smallholder Farms of the Western Kenya Highlands

MARK T. VAN WIJK[1], PABLO TITTONELL[2], MARIANA RUFINO[1], MARIO HERRERO[3], KEN GILLER[1]

[1] *Wageningen University, Plant Production Systems, Department of Plant Sciences, Netherlands*

[2] *International Centre for Tropical Agriculture, Tropical Soil Biology and Fertility, Kenya*

[3] *International Livestock Research Institute (ILRI), Kenya*

In many highland areas of Africa population growth has led to farm sizes smaller than 1 ha and to the (virtual) extinction of communal land. In spite of the agroecological potential of these areas, food security is often achieved by less than 20 % of the households. This is caused by multiple factors; soil fertility depletion due to continuous cultivation, soil water erosion, and limited nutrient inputs to the farm system. A range of nutrient management technologies have been proposed to counterbalance these problems. However, their adoption is restricted by lack of land, financial resources and labour. The latter is counter-intuitive, as one may assume that labour is amply available in highly populated regions; however, labour demands for different activities take place at peak periods during which farmers need to hire external labour. Thus, any strategy to increase food production, improve resource use efficiency and/or maintain the resource base should be designed by considering the dynamics of labour allocation to competing farm (and non-farm) activities. We developed a modelling framework that includes the spatial and temporal dimensions of smallholder farming systems to be able to analyse these issues. By using summary models that describe the short- and long-term dynamics of the major components of the farming systems (livestock, crop/soil, labour/finance) we are able to synthesize knowledge and analyse trade-offs of implementing different management technologies. Analysis using the model framework showed how different labour and cash constraints limit the possibilities for intensification of the farming system for farmers of different resource endowment.

Keywords: FARMSIM, household modelling, nutrient management, soil fertility, sub-Saharan Africa

Contact Address: Mark T. Van Wijk, Wageningen University, Plant Production Systems, Department of Plant Sciences, Haarweg 333 (PO 430), 6700 AK Wageningen, Netherlands, e-mail: mark.vanwijk@wur.nl

Boda-bodas Rule: the Poverty and Inequality Implications of Non-farm Activities in Western Kenya

JANN LAY[1], GEORGE MICHUKI[2], TOMAN OMAR MAHMOUD[1]
[1]*Institute for the World Economy, Poverty Reduction, Equity and Development, Germany*
[2]*German Institute for Global and Area Studies, Hamburg, Germany*

Several reasons have been advanced for income diversification into nonfarm activities among rural households in Sub-Saharan Africa. Broadly, one may classify diversification behaviour as 'survival-led' or 'opportunity-led'. Poor rural households with low asset endowments will embrace multiple livelihoods to ensure survival. At the same time, richer rural households with higher asset endowments will choose to diversify their livelihoods to maximise returns to their assets. The existence of these two types of non-agricultural activities implies a U-shaped relationship between the share of income derived from nonfarm activities and household wealth (and accordingly total household income). According to this view on nonfarm activities, the poverty and distributional impact of nonfarm activities should be ambiguous: 'Survival-led' engagement in non-farm activities should be inequality decreasing through increasing the incomes of the poorer parts of the population and hence reduce poverty. 'Opportunity-led' diversification however would increase inequality and have a minor effect on poverty, as it may be confined to non-poor households. Some authors have pointed to this ambiguity, but the literature has so far not explicitly addressed the relationship between different diversification strategies, on the one hand, and poverty and distributional outcomes, on the other. In this paper, we first attempt to confirm empirically that diversification into nonfarm income can be 'survival' or 'opportunity' driven. We estimate a choice model where we allow individuals to choose between staying in agriculture and the two types of nonfarm diversification using data from a household survey conducted by the authors in Kakamega district in Western Kenya. Our empirical findings seem to confirm the existence of 'survival-led' and 'opportunity-led' diversification. We find the poverty and inequality implications of the differently motivated diversification strategies to correspond to the expected patterns.

Keywords: Income diversification, inequality, nonfarm activities, poverty

Contact Address: Jann Lay, Institute for the World Economy, Poverty Reduction, Equity and Development, Duesternbrooker Weg 120, 24105 Kiel, Germany, e-mail: jann.lay@ifw-kiel.de

Linking Local Resources to SME Development. A Pathway Out Off Poverty?

UTE RIETDORF[2,1], ROBERT KAPPEL[1], WILSON OLARASHA KAIKAI[2]
[1]*German Institute of Global and Area Studies (GIGA), Hamburg, Germany*
[2]*University of Leipzig, Small Enterprise Promotion and Training (SEPT), Germany*

After decades of different approaches, most rural areas are still the poorest regions of their countries, struggling with a host of disadvantages compared to urban ones. One of the options discussed to bridge the inter-regional gap in a globalised world is the development of small scale enterprises (SMEs) in rural areas. Based on the use of local resources in terms of land, human and social capital as well as biodiversity, non-farm enterprises and off-farm activities are regarded as solutions to earn more, to spread the risk of household incomes, to accumulate capital, and to have a positive impact on regional development by providing employment and linking different sectors of the economy.

Yet the complex interrelationship of the agricultural and manufacturing sector in rural locations and towns is barely understood in its full scope of interdependent factors. This relationship is a market-related one and depends on the growth of both sectors. Research undertaken in 2005/beginning of 2006 indicated that the linkage potential fuelling regional economic development seems to be positively influenced by producing cash crops like sugar cane. At the same time, this raises questions of the long-term competitiveness of the related industry which subsequently affects the sustainability of agricultural income and thus the linkage potential.

In the rural context of Kakamega District, Kenya the issue of linkages between the farming sector and the development of small scale enterprises concerns not only the level of income that can be achieved through diversification of activities nor only the amount of investment necessary to start a venture or upgrade agricultural production. The potential for linkages to generate income is also influenced by the population growth rate, high dependency ratios, land scarcity, declining soil fertility, locational and institutional disadvantages arising out of infrastructural problems. In making references to a comparative study done in Kasama District, Zambia, possible patterns of regional development and pathways to strengthen inter-sectoral linkages emerge.

Keywords: Linkages, poverty reduction, regional development, SME development

Contact Address: Ute Rietdorf, German Overseas Institute (DUEI)/University of Leipzig, University of Leipzig: Sept (Small Enterprise Promotion and Training), An Der Luppe 39, 04178 Leipzig, Germany, e-mail: rietdorf@uni-leipzig.de

Estimating Recreational Benefits of Kakamega Forest in Kenya Using the Travel Cost Method

DAVID MUGAMBI[1], DANIEL MUGENDI[1], ANTHONY WAMBUGU[2], JOHN MBURU[3]

[1]*Kenyatta University, Environmental Science, Kenya*

[2]*Kenyatta University, Economics, Kenya*

[3]*University of Bonn, Centre for Development Research (ZEF), Germany*

Forests have high use and non-use values. They act as good reservoir for both wildlife and forest biodiversity among other benefits. Kakamega Forest is a unique example of the few remaining fragments of the tropical rain forest, a rare ecosystem found in the tropics. The forest has rich diversity of fauna and flora. It is an important tourist destination which attracts both local and international tourists who visit throughout the year. With such a recreational demand, there is dire need to estimate the recreational benefits for this forest. Thus, the core objective of this study is to apply the zonal travel cost method to estimate the recreational benefits of the forest. In order to achieve this objective the study relies on past records of the tourists' numbers and their countries of origin. The data was collected from two main forest sites: Kakamega Forest Reserve which is managed by the Forest Department and Kakamega National Forest Reserve which is under the management of Kenya Wildlife Services. The collected data was appropriately analysed to estimate the recreational value of the forest. The preliminary result from this study shows that the annual recreational value of Kakamega Forest part under Kenya Wildlife Service has high magnitude than that of Forest Department. Thus, the results reveals that the areas of forest which are well conserved and protected yield high recreational benefits. The study concludes by giving appropriate policy guidelines with recommendations on how to improve the management and protection of Kakamega Forest biodiversity for both direct and indirect benefits.

Keywords: Forest values, recreational value, travel cost method

Contact Address: John Mburu, University of Bonn, Centre for Development Research (ZEF), Walter-Flex-Str. 3, 53113 Bonn, Germany, e-mail: jmburu@uni-bonn.de

Participatory Land Use Planning for the Protection of Biodiversity

KARIN GAESING, WONDIMU KENEA
University of Dortmund, Faculty of Spatial Planning, Germany

Poor households reduce their expenditures and earn their living by using 'free' resources from the forest. In Kakamega Forest in Kenya this has led to a devastating destruction of biodiversity. Such a situation requires not only solutions on the individual farmer's side, but also collective action within the communities living close to the forest, the formulation and implementation of appropriate policies to protect biodiversity and competent actors with the possibility to embark on concerted action. Participatory land use planning has proved to be a method that can provide a platform for discussion of problems, solutions and different options. It can bring different stakeholders together for planning and implementation and it has the possibility to implement identified solutions, if Government, administration and NGO/CBO are properly involved in the process. The poster explains the method of Participatory Land Use Planning, its usefulness with regard to the protection of biodiversity as well as the link between participatory research and policy formulation.

Keywords: Biodiversity, buffer zone, livelihoods, participatory land use planning

Contact Address: Karin Gaesing, University of Dortmund, Faculty of Spatial Planning, Schlossstr. 78, 33824 Werther, Germany, e-mail: karin.gaesing@web.de

Implications of Differential Nutrient Flux Management on Soil Fertility and Crop Productivity in Major Farm Types of Kakamega, Kenya

THUWEBA DIWANI, MATHIAS BECKER

University of Bonn, Institute of Crop Science and Resource Conservation - Plant Nutrition, Germany

Small-scale farms, ranging from subsistence to market oriented production, dominate the agricultural matrix in Kakamega District in Kenya. Main components of most of these farms are field crops, dominated by maize-bean intercropping, home gardens with fruit trees and vegetables, and forage production patches. An additional feature of the market-oriented farms is the production of industrial crops such as tea (predominant on Ultisols in the south of the district) and sugarcane (predominant on sandy Alfisols in the north of the district). Variable soil fertility and declining crop yield trends have been recorded during the past decade and were associated with land use intensification in the absence of external input use and a poor crop residue management. In two-year on-farm observation trails in 16 representative farms, the large spatial variation in soil fertility, both within and between farms, was studied. Resource flow mapping was related to crop yield and soil fertility. Farms were classified into two categories: **(1)** small, largely subsistence-oriented farms with maize yields $<$ 1 Mg ha^{-1} and **(2)** larger market-oriented farms with diverse crops and usually maize yields exceeding 1.5 Mg ha^{-1}. In each of the major soil types (Alfisol and Ultisol) four farms of each category were selected (16 farms). Nutrient balances (N, P, K) at farm and plot level and resource flow maps (inputs, products, labour) were established and linked to soil fertility descriptors (org. C fractions, pH, avail. P). Additionally, the effects of selected soil fertility-enhancing technologies (mineral fertiliser use, application of farm yard manure and *Tithonia diversifolia*, and leguminous live-mulches) on nutrient flows and budgets were evaluated. Data were analysed by the NUTMON model in view of evaluating resource base quality scenarios and to define and target site and system-specific intervention strategies.

Keywords: Bean, Maize, NUTMON, Resource flow mapping, Tithonia

Contact Address: Thuweba Diwani, University of Bonn, Institute of Crop Science and Resource Conservation - Plant Nutrition, Karlrobert-Kreiten-Strasse 13, 53115 Bonn, Germany, e-mail: thuwebadiwani@yahoo.com

The Contributions of Nitrogen Fixation by Field-grown Common Beans to N Balances in Agricultural Production Systems of Kakamega District

FRANCIS E.A. NGOME, FRANK MUSSGNUG, MATHIAS BECKER
University of Bonn, Institute of Crop Science and Resource Conservation - Plant Nutrition, Germany

Land use and cropping intensification without resource base conservation causes a decline in soil fertility, which limits agricultural production in Western Kenya. Widespread N and P deficiencies appear to be the main culprits of the observed declining yield trends. The common bean (*Phaseolus vulgaris* L.) is widely cultivated for subsistence by farmers on 60–80 % of their agricultural land area. This field-grown common bean is likely to contribute N by BFN which might differ between soil types and cropping or management systems. Hence, field experiments were conducted in 21 selected prototypic farmers' fields in Kakamega District, Kenya, during the short rains of 2005. The biomass, N accumulation, and the share of N derived from BNF (^{15}N natural abundance method) by common beans were determined under 7 management scenarios. The total N accumulation by common bean ranged from 6–83 kg ha^{-1} with some 4–55 kg ha^{-1} derived from the soil and the remainder being derived from BNF. The sole crop common bean accumulated 2 times more biomass and BFN-N compared to the intercrop, and treatments in the Alfisol accumulated only 70–80 % compared to those of the Ultisol zone (3–27 kg N ha^{-1}). In addition, the share of N derived from the atmosphere (%Ndfa) was 20–54 and 19–50 %Ndfa for the Alfisol and Ultisol zones, respectively. Meanwhile the %Ndfa under farmers' management was only 30–39 % in the Alfisol and 21–33 % in the Ultisol. This share of biologically fixed N was larger in mixed maize-common bean than in sole crop situations. The addition of organic or of mineral N fertiliser tended to reduce %Ndfa, while improved weed control and P fertiliser application resulted in a significant increase in N accumulation and Ndfa. It may be concluded that field-grown common beans have the potential to contribute to the N pool of the cropping system of Western Kenya by BNF. However, this will largely depend on P application and weed control.

Keywords: Biological N_2 fixation, delta 15-N, Kenya, *Phaseolus vulgaris* L

Contact Address: Frank Mussgnug, University of Bonn, Institue of Crop Science and Resuorce Conservation-Plant Nutrition, Karlrobert-Kreiten-Straße 13, 53115 Bonn, Germany, e-mail: f.mussgnug@uni-bonn.de

Bee Pollinator Species in Kakamega Farmlands as Influenced by Kakamega Forest, Kenya

JOHN MUO KASINA[1], DIETER WITTMAN[2], CHRISTOPHER MARTIUS[1], MANFRED KRAEMER[3]

[1]*University of Bonn, Centre for Development Research (ZEF), Germany*

[2]*University of Bonn, Institute of Crop Science and Resource Conservation - Ecology of Cultural Landscapes, Germany*

[3]*University of Bielefeld, Biological Collection, Germany*

Bees have been relied on world-over as the main pollinators of crops in agricultural systems. Honey bees (*Apis mellifera* L.) are the most highly utilised pollinators in these systems because of their easy domestication. However, continued research has shown that some solitary bees are better pollinators of particular crops, hence the changing perception of pollinator needs of different crops. In agriculture, it is generally agreeable that inputs such as fertiliser, labour or capital could limit crop production and hence are given priority. However, pollination is not well appreciated as a limiting factor of production though it can limit crop yields. This is mainly due to the fact that it is an ecosystem service that has been perceived as 'free' and plenty, a common characteristic of public goods/services. But due to the continued destruction of ecosystems and the resultant decline of pollinators, the pollination service has become an important factor of production to consider. Kakamega forest is the only remaining forest patch of the guineo-congolian rainforest that used to span from West Africa through central to eastern Africa. It is a main habitat for pollinators that support pollination needs of many crops in the surrounding farmlands. The farmlands are characterised by continued degradation of the pollinator habitats due to the intensity of farming, and it is not known the impact this has on the pollinator abundance and diversity on the farmlands. This study was undertaken to determine the effect of the forest (distance) on the bee pollinator activity density (abundance) and diversity in the farmlands up to 8km away from the forest. Dry common bean (*Phaseolus vulgaris* L.) was used for this study, because it is planted by almost all farmers and hence can provide an overview of the bee pollinators in the farmlands. Initial findings indicate that some bee species are influenced by the distance to the forest and bee activity density was different in the north and south of the forest.

Keywords: Beans, honeybees, kakamega farmlands, Kakamega forest, solitary bees

Contact Address: John Muo Kasina, University of Bonn, Centre for Development Research (ZEF), Walter Flex Str.3, +149 Bonn, Germany, e-mail: jkasina@yahoo.com

Impact of Climate Variability and Land Cover Changes on Agriculture, Biodiversity, and Human Health in West Africa

JOERG SZARZYNSKI, CHARLES RODGERS, PAUL L. G. VLEK
University of Bonn, Center for Development Research (ZEF), Germany

The vulnerability of West African countries to climate and environmental changes is likely to increase within the next decades as demands on resources continuously rise in association with rapidly growing populations. In addition, there has been a growing awareness of the fact that human-induced environmental changes also raise the risks to human health. In recognition of the societal need for improved prediction of the current and the expected future climate change, and to develop strategies to reduce the socio-economic impact, interdisciplinary research is required. Thus, an integrative multiscale monitoring concept was designed within the framework of the GLOWA Volta and BIOTA West Africa scientific research networks, funded by the Federal German Ministry for Science and Education (BMBF) in cooperation with several counterparts from Burkina Faso, Ghana, Benin, and Côte d'Ivoire. The instrumental monitoring system, described as "Biophysical Observation Network" (BON), combines important features of biophysical ground measurement and remote sensing techniques. The multiscale data collection from the experimental sites is progressively incorporated into a web-based GIS database. The sites are used for comprehensive ground-truth surveys, essential for the assessment of accuracy of classified satellite imagery. Additionally, they serve to build capacity in the region by providing training opportunities for local students and research scientist. This paper presents results and perspectives regarding the impact of weather fluctuations and climate variability on ecosystems, biodiversity, and human health in West Africa. Different scales are considered since the spectrum of processes determining weather conditions in West Africa ranges from the propagation of planetary Rossby waves on the global scale to small-sized changes in land cover on the regional to local scale. Land degradation is associated with changes of biophysical surface properties such as albedo or roughness. These modifications again lead to surface cooling, lowered atmospheric heating rates and reduction in convection. The resulting diminution of surface pressure decreases within the equatorial trough in turn weakens the African monsoon flow and the associated moisture flux convergence finally causing a pronounced decrease in rainfall and evaporation.

Keywords: African monsoon, biodiversity, BIOTA , climate variability, GLOWA Volta, scaling issues

Contact Address: Joerg Szarzynski, University of Bonn, Center for Development Research (ZEF), Walter-Flex-Straße 3, 53113 Bonn, Germany, e-mail: szarzynski@uni-bonn.de

Fundación Vuelta Larga in Northeast Venezuela: Development of Environmentally Friendly Rural Technologies and Nature Conservation Strategies

INGRID REIBER[1], KLAUS MÜLLER[2], GREGOR MAISENBACHER[3], RAINER SCHULTZE-KRAFT[1]

[1]*University of Hohenheim, Biodiversity and Landrehabilitation in the Tropics and Subtropics, Germany*

[2]*Fundación Vuelta Larga, Venezuela*

[3]*University of Hohenheim, Tropennetzwerk e.V., Germany*

As people become strangers to nature and ecosystems deteriorate and disappear, new approaches to counteract such deterioration are ever more important. The goal of the Fundación Vuelta Larga, a private foundation created in 1988 in Sucre, Venezuela, is to create public awareness in support of sustainable environment and use of environmentally friendly technologies, based on experiences and demonstrations examplified on an 800 ha area adjacent to the Parque Nacional Turuépano. 80–100 years ago, the vegetation was a high-water table influenced tropical rainforest which because of forest clearing and burning degraded into a savannah floodplain with scattered trees. The foundation's main objective is vegetation restauration and creation of a bufferzone for the Turuépano park including reforestation, reintroduction of endangered species, housing with tropical architecture and tropical furniture, traditional indigenous handicraft, and adapted agriculture and aquaculture. The work is funded by income from ecotourism. The "Ruta de las Cumbres", an ecotourism pilot project of regional and national importance, offers ecotourist visitors an insight into sustainable rural development projects via a tour through the mountains. Rural development and environmental education workshops for multiplicators are organised in cooperation with the Ministries of Education and Environment. Within educational activities, an important project is the establishment and promotion of tree nurseries in schools. Current scientific studies are about butterfly diversity and the development of secondary forests, particularly about the role of *Erythrina fusca* ("bucare"), a leguminous pioneer tree well adapted to seasonal flooding. In the last 30 years, trees were planted along the boundaries of the foundation's area and along watercourses in order to accelerate the development of secondary forests. Time series of such forests are currently mapped to compare their bucare-influenced regeneration with an area without bucare. Preliminary results show that the savannah where no bucare was planted could not develop into forest although there was no fire during the last 35 years. In the bucare-influenced secondary forests of the savannah, 10 different tree species were found whereas in the bordering hill forests more than 40 species appear.

Keywords: Bufferzone, *Erythrina fusca*, floodplain, savannah, reforestation

Contact Address: Ingrid Reiber, University of Hohenheim, Biodiversity and Landrehabilitation in the Tropics and Subtropics, Garbenstrasse 13, 70593 Stuttgart, Germany, e-mail: inreiber@web.de

Resource and Policy Economics

Economic Valuation

The Cotton Chain in Central Asian Uzbekistan: One Step Forward, two Back?

INNA RUDENKO

University of Bonn, Center for Development Research (ZEF), Germany

The cotton sector, contributing a considerable share to total export revenues, always was of paramount importance to Central Asian Uzbekistan. However, it also was blamed as the cause for the human-induced ecological disaster in the Aral Sea Basin. Concurrently, affected by fluctuations in prices at the world cotton market, the export of cotton fiber caused the Government of Uzbekistan (GoU) between 1998–2001 a loss of USD 1.479 bln. Hence a continuation of the cotton monoculture and export of low value fiber can no longer be regarded as the vehicle for a permanent, broad-based, and environmentally sustainable growth. A shift from the primary commodity exports to the export of value added cotton products and the removal of trade barriers became key of recent reforms. The GoU and the private sector have shown in the recent past substantial interest in reviving the cotton-textile sector by supporting foreign direct investments, the emergence of numerous textile Joint Ventures, creating a favourable climate for textile enterprises, simplifying taxation, and granting exemption from customs duties and discounts on the purchase of cotton fiber. A Value Chain Analysis (VCA) was applied to examine existing and newly established cotton-textile companies and recent developments in the Khorezm Region as an example for Uzbekistan. VCA linked agriculture, ginning and textile industries in one cotton value added chain and provided a comprehensive picture of the process of creating value added. VCA allowed a closer insight on interactions among all actors in the entire chain and GoU. Finally, VCA revealed both the impact of present regulations and reforms on the cotton textile sector and obstacles for its further development into a sector with comparative and competitive advantages. There is room for improvement of the ecological and economic situation in Uzbekistan if anticipated reforms are streamlined and sequentially consider the whole cotton chain rather than the state revenues.

Keywords: Comparative advantages, cotton, value chain analysis

Contact Address: Inna Rudenko, University of Bonn, Center for Development Research (ZEF), 14 Khamid Alimjan Street, 740000 Urgench, Germany, e-mail: inna@zef.uzpak.uz;irudenko@uni-bonn.de

Implication of Project Intervention on Poverty Alleviation and Sustainable Livelihoods

LILA KARKI[1], SIEGFRIED BAUER[1], UMA KARKI[2]

[1]*Justus-Liebig-University Giessen, Institute of Agriculture and Food Systems Management, Germany*

[2]*Auburn University, College of Agriculture, USA*

The number of people living under poverty is still very high despite numerous poverty alleviation programs launched over the years. Although several development models and approaches have been practised, 38 % population in Nepal still live in dire poverty. Many of the projects to trim down poverty have been supported by multi and bilateral agencies in one or the other form. However, assessment of impact of such interventions has yet to emphasise specifically at micro level. Therefore, this study was conducted to assess the socio-economic impacts that accrued to the beneficiary of subsistence farm community and to delineate the relationship with sustainable livelihoods.

A randomised household survey was conducted to collect field data applying a multistage random sampling technique for 120 households in the mid hills, Nepal. The data has been analysed using descriptive statistics, qualitative tools and econometric models. To net out the impacts due to project intervention on peoples' livelihood, income measures, consumption pattern, head count index of the respondents, and poverty gap techniques have been used.

Analyses for some socio-economic and ecological variables like derived income and food self-sufficiency level, a positive but not significant impact is identified. The influence on ecological development, equity in resource allocation and sharing benefits between male and female farmers and opportunity for capacity building indicators have been found positively significant. However, beneficiaries' participation during project planning and performance evaluation phases has been disregarded.

Assessment of impact of development activities helps allocate resources optimally thereby enhancing the benefits from future projects. Therefore, impact evaluation at grass-root level and beneficiaries' capacity building on planning and evaluating performances should always be given top priority.

Keywords: Buffalo enterprise, factor productivity, rural economy, women empowerment

Contact Address: Lila Karki, Justus-Liebig-University Giessen, Institute of Agriculture and Food Systems Management, Senckenbergstraße - 3, D-35390 Gießen, Germany, e-mail: Lila.Karki@agrar.uni-giessen.de

Economic Analysis of Agricultural Reforms in Khorezm Region (Uzbekistan)

NODIR DJANIBEKOV
University of Bonn, Center for Development Research (ZEF), Germany

Since 1991, there have been various reforms implemented in agricultural sector of Uzbekistan to achieve gradual transition from socialistic to market-oriented economy. These reforms have included market liberalisation, reformation of land relations, structural changes, and creation of supporting market infrastructure. At the same time, the state policy on agricultural sector development has emphasised cotton production as an element of stable export revenues and agricultural revenues as subject to redistribution to industrialisation. According to market liberalisation programme and implementation of the state policy on agricultural development, agricultural product markets were liberalised. However, production and input use decisions have been dominated by administrative methods of economic regulation such as state procurement quota and price control.

Within the framework of agricultural reforms, the farm restructuring and land reform have been implemented. The government originally intended a change in the farming institution from collective to private farm-based system. Nevertheless, shift in farming system has been achieved without introduction of the concept of land property, remaining land under the state ownership. Moreover, the transition to market-oriented economy includes transformation of agricultural subsidisation policy to the extent that it does not degrade producer incentives. The focus of the economic analysis is on the agricultural reforms in Uzbekistan such as market liberalisation, land and water reforms. The analysis relies on a partial equilibrium model developed for the agricultural sector of Khorezm region of Uzbekistan to assess the effects of these reforms on the regional crop and livestock production. The model includes different farm subaggregates with various production technologies and resource endowments distributed through number of production districts. The comparison of single scenarios and their combinations is given to determine the changes in production through the gradual application of the reforms. This study revealed that the highest level of welfare is possible in application of complete package of reforms, which would include water pricing, state order abolishment, completion of decollectivisation process.

Keywords: Khorezm region, land reform, regional modelling, state order, water pricing

Contact Address: Nodir Djanibekov, University of Bonn, Center for Development Research (ZEF), Walter-Flex Str 3, 53113 Bonn, Germany, e-mail: nodir@uni-bonn.de

Methodology for Economic Valuation of Food Security and Vulnerability to Poverty for Inland Fisheries in Africa

RUDOLF WITT[1], LEVISON CHIWAULA[1], CHRISTOPHE BÉNÉ[2], HERMANN WAIBEL[1], DIEMUTH PEMSL[3]

[1]*Leibniz University Hannover, Development and Agricultural Economics, Germany*

[2]*Consultative Group on International Agricultural Research (CGIAR), Worldfish Center, Egypt*

[3]*WorldFish Center, Policy, Economics, and Social Sciences, Malaysia*

Fish play an increasingly important role in national and local economies of many developing countries. Africa's rivers, wetlands and lakes are especially important for poor rural households for whom they provide employment and income opportunities in areas where other economic alternatives are scarce or inexistent. They also provide nutritional safety-nets in these regions with limited roads and access to market.
However, policy makers and regional decision makers tend to underrate fisheries, in particular inland small-scale fisheries. Often preference is given to large-scale irrigation projects, in an attempt to increase agricultural productivity, or to electricity-generating dam projects, without necessarily recognising and integrating the role played by small-scale fisheries for local economic development and food security.
This study contributes to an economic assessment of the food safety value of inland fisheries. The objectives are **(1)** to develop an adapted portfolio of methodologies for inland fisheries valuation, and **(2)** to conduct an in-depth socio-economic study in the Lake Chad Basin, more precisely, in Cameroon and Nigeria. The paper presents a methodology that captures the following:
Using the Vulnerability as Expected Poverty concept, the susceptibility of fishery dependent households to micro and macro shocks will be assessed. The computation of a vulnerability scale is expected to clarify the relationships between fishery-related activities and poverty as well as between socio-political determinants and poverty.
The methodology will be applied in the context of an empirical study carried out in collaboration with the WorldFish Centre, in five African countries: Cameroon, Nigeria, Niger, Malawi and Zambia.

Keywords: Inland fisheries, non-market valuation, Sub-Saharan Africa, vulnerability

Contact Address: Rudolf Witt, Leibniz University Hannover, Development and Agricultural Economics, Hannover, Germany, e-mail: witt@ifgb.uni-hannover.de

Indicator Based Poverty Assessment among Rural Households in Central Sulawesi, Indonesia

XENIA VAN EDIG[1], STEFAN SCHWARZE[1], MANFRED ZELLER[2]

[1]*Georg-August-Universtiy Göttingen, Department of Agricultural Economica and Rural Development, Germany*

[2]*University of Hohenheim, Institute of Agricultural Economics and Social Sciences in the Tropics and Subtropics, Germany*

Targeting is decisive for the success of development programs and projects focusing on poverty reduction. Hence, a project or programme that seeks to reduce poverty has to find out which households live in extreme poverty. This assessment requires costly, time intensive large-scale surveys. Therefore, there is a need for cheap, time-saving and easy-to-implement poverty assessment tools. The assessment of absolute poverty as well as the definition of suitable indicators to predict absolute poverty among rural household in Central Sulawesi, Indonesia, are the objectives of this paper. The developed poverty assessment tool can be offered to local NGOs and help to reduce poverty in the region. Data was collected from 279 randomly selected households in 2005. From the expenditure data the daily per capita expenditures are derived. The log of this variable is the dependent variable in the regression models. A household is classified as very poor when the expenditures are below IDR 2723 per household member and day, which is equivalent to 1 US$ PPP. 19.35 % of the households in the research area fall short this poverty line. Beside the expenditure data, indicators of various dimensions of poverty were surveyed and the independent variables for the regressions were derived from these indicators. Applying different multivariate regression models (one-step OLS, two-step OLS and Quantile regression), we analysed which set of indicators yields the highest Balanced Poverty Accuracy Criterion (BPAC). BPAC is defined as the accuracy among the very poor minus the absolute deviation of undercoverage and leakage. We only included indicators in the model which are easy-to-survey to assure that the tool is applicable at low costs. One-step Quantile regression yields the highest BPAC of 72.22 %. For applying the model in practice, NGOs need to survey the found indicators, multiply them with the coefficient from our regression model, sum them up, and add the constant. If the value is below the poverty line, the household can be categorised as very poor.

Keywords: Indicators of poverty, Indonesia, poverty assessment

Contact Address: Xenia Van Edig, Georg-August-Universtiy Göttingen, Department of Agricultural Economica and Rural Development, Göttingen, Germany, e-mail: xedig@agr.uni-goettingen.de

Human-ecological Investigation on the Land Use of Flowery Hmong to Overcome Poverty: a Case Study from Lao Cai Province, Vietnam

HAI NGUYEN TIEN, HOLM UIBRIG

Dresden University of Technology, Institute of International Forestry and Forest Products, Germany

In the context of the economic renovation, Vietnam has transferred land-use rights from state and cooperative units under central planning to individual, community and other entities with market orientation. Despite remarkable success in lowland agriculture the advancement within the uplands stays behind the political targets. These regions are predominantly inhabited by ethnic minority groups. The relative isolation from the markets, the ethnic group and location specific customary and subsistence oriented livelihood on the one hand and state claims to implement the governmental forest land-use policy and management on the other hand cause particular problem situations of the local human ecosystems.

This ongoing study examines current land-use systems and seeks to find out potentialities to harmonise the relevant legal regulations with the customary land-use management. Arguments should be elaborated for the continued rural development adopting both the state land-use policy and customary land-use management. In a selected village area the mosaic of land utilisation is analysed from the viewpoint of the villagers, Flowery Hmong, and of the management board of the 661 project which is striving for afforestation/ regreening of state claimed protection forest land.

The analysis adopts the 'Human Ecosystem' model as developed by Machlis et al. (1997). It combines 'critical resources' of both the social and the ecosystem and puts them in relation to attributes of 'social order', 'institutions', and 'cycles' of the social system. A tool mix of the RRA approach was used to collect mainly qualitative primary data. The results show the land-use system in the village area and influencing endogenous and exogenous factors. Among them the first ranking is to secure sustenance of the villagers. Furthermore, the results enlighten the current conflict on land and forest utilisation. This has been caused by the governmental land area claims for the 661 project not taking into account the locally available resources for making a living. It is concluded that real participatory land use planning and land allocation could facilitate local people based land and forest land resources management.

Keywords: Customary claims, Market orientation, Participatory planning, Self-sustenance, State land-use policy

Contact Address: Holm Uibrig, Dresden University of Technology, Institute of International Forestry and Forest Products, Pienner Strasse 7, 01737 Tharandt, Germany, e-mail: druibrig@forst.tu-dresden.de

Performance Assessment of Land Enhancing Technologies: an Economic Analysis for Food Crop Farmers in Southwestern Nigeria

LUKE OLARINDE

Ladoke Akintola University of Technology, Department of Agricultural Economic and Extension, Nigeria

Many consumers' behaviour shows that their (consumers) general preferences for the attributes or traits of products are subjective. More so, their perceptions of and impressions about the characteristics of the products affect significantly their demand for them. Consumers' preferences for agricultural products are however subject to their availability in motivating qualities and quantities. In turn, farmers' role in preferential adoption decisions, which enhance agricultural productivities and crops' qualities, have had very limited attention in research. This forms the basis of this paper. Two sets of improved management systems introduced by the Oyo State Agricultural Development Project to food crop farmers were investigated for their performances. These involve the adoption of land enhancing technologies that include **(1)** repeated leguminous cover crops and **(2)** appropriate fertiliser application. A participatory survey was conducted with one hundred and eighty (180) food crop farmers in five differently scattered farming communities in the derived savannah agro ecological belt of south western Nigeria. The main aim of the survey was to identify the farming methods practised by the sampled farmers , analyse the economic efficiency of each method, and determine the socioeconomic and demographic factors, farm specific and other intrinsic "risk" factors affecting the farmers' productivity. Though both farming methods showed significant improvement in terms of crop yield over the yields on farm lands with partial or no application of any of these technologies, financial returns from both methods are found to be almost at par with probable overwhelming financial returns from the method of the "leguminous cover crops" in the nearest future. The paper also showed that the framers' choice for any of the two introduced land enhancing technologies depends largely on the food crop type cultivated. From the findings, a reach out to all case is made for peasants who appear inaccessible by the agricultural development project's agents to incorporate them into the main scheme of better and improved agricultural management technologies. This will enable a wider acceptability of these technologies and many other ones that are suited for differing farming communities.

Keywords: leguminous cover crops, management technologies, preferential adoption

Contact Address: Luke Olarinde, Ladoke Akintola University of Technology, Department of Agricultural Economic and Extension, 4000 Ogbomoso 210001, Nigeria, e-mail: lolarinde@yahoo.com

Why Do Farmers Adopt Alternative Vegetable Production Technologies? : Descriptive Analysis of Vegetable Farmers and Farmers' Knowledge and Attitude

THANAPORN KRASUAYTHONG, HERMANN WAIBEL
University of Hannover, Development and Agricultural Economics, Germany

Much of commercial vegetable production in Thailand is monoculture with high use of agrochemical inputs particularly pesticides. These have become a main cause of health hazard and environmental degradation in agricultural systems. As a response to this problem, alternative vegetable production technologies have been developed. However, until now vegetable farmers adopted such technologies on a very low scale. One among several determinants for low adoption rate is riskiness of new technologies. Such technologies are often viewed as being more risky because they usually require restricted use of risk-reducing agrochemical inputs.

This paper shows the results of applying a comprehensive methodology to assess adoption of alternative agricultural production technologies in commercial vegetable production systems. Risk consideration were incorporated in the adoption model, to clarify to what extent differences exist in terms of preference and behaviour between adopters, non-adopters and disadopters. The study was carried out in four steps. In the first step, a workshop with academicians and experts experienced in vegetable production and marketing of vegetable products was conducted in order to provide background information for drawing the definition of alternative vegetable production technologies and the definition of an adoption threshold. Based on the workshop results, an adoption survey was conducted with 297 farmers in 2005 in selected districts of Northern Thailand. In the third step, a simultaneous multivariate choice model applying a Heckman procedure was developed to identify economic and behavioural factors affecting the adoption of the alternative vegetable production technologies. The adoption categories were established by following the results of the workshop, i.e. the adoption threshold based on farmers' practices and knowledge of the alternative vegetable production technologies. As a final step, the farm level and the policy implications of the adoption factors identified are discussed.

Keywords: Adoption, farmers' preferences, Thailand, vegetable

Contact Address: Thanaporn Krasuaythong, University of Hannover, Development and Agricultural Economics, Königswother Plazt 1, 30167 Hannover, Germany, e-mail: kthana@ifgb.uni-hannover.de

Socio-economic Analysis of Vegetables Production and Marketing - a Case Study of N'djamena

DIOP ABDALLAH[1], GONGNET GBEUKOH PAFOU[2]

[1]*High School of Science and Technique of Agriculture and Forest (ESTAF), Plant Production, Chad*

[2]*University of N'djaména, Faculté des Sciences Exactes et Appliquées, Ecology, Chad*

Agriculture is often the most important economic sector in the developing countries. In Chad 80 % of the active population is engaged in agricultural activities and agriculture contributes up to 50 % of the GNP. Vegetables are of great importance in Chad in twofold sense — as food and as commercial products. They are of economic interest from several points of view. Where the opportunities for sale are good (from middle of February till end April in case of Market in N'Djaména), vegetables are among the most profitable agricultural products. In the past decade the consumption of vegetables in N'Djaména increased and reached currently about 30 — 45 $^{kg}/_{person}$/year.

The objective of this Study was to evaluate the socio-economic status of vegetables producers and sellers, by identifying at first their difficulties during the production, followed by analysing the methods of products sale in different markets in N'Djaména and finally to propose recommendations.

The Data were obtained from the survey by administering to a standardised questionnaire to 40 randomly selected vegetables producers in four areas [Ligna, Djeddaya (localised along the Chari-River), Karal and Lakechad]. Supplementary data were obtained through key person interviews

(n = 20) and field observations. The cultivated vegetables, which this study considers, are tomato, sweet potato, cabbage, okra and salad.

The results indicate that the average of cultivated land is 0.25 — 0.35 ha per farmer, in LakeChad it can be more than 1 ha. The largest proportion of marketed vegetables is produced in the area of the Lake-Chad. It was find out, that some agronomical, technical and economical difficulties have been met during the cultivation. The impact of this is reflected in levels of farm incomes. The examined indicators show that generally the socio-economic status of vegetables producers is ameliorated in all investigated areas. Finally, methods how to ameliorate the production and to generate supplementary financial income through new model of marketing were recommended.

Keywords: Vegetables, Marketing, N'Djaména, Production, socio-economic Analysis

Contact Address: Diop Abdallah, High School of Science and Technique of Agriculture and Forest (ESTAF), Plant Production, B.P. 1709 N'Djaména Tchad, N'Djaména, Chad, e-mail: adiop@gmx.net

A Socio-economic Evaluation of Agricultural Diversification in the Demerara-mahaica Administrative Region of Guyana

RICHARD BLAIR[1], WERNER DOPPLER[2]

[1]*University of Hohenheim, Agricultural Economics and Social Sciences in the Tropics and Subtropics, Germany*

[2]*University of Hohenheim, Farming and Rural Systems in the Tropics and Subtropics, Germany*

Income insecurity is inextricably linked to poverty and by extension living standard. At the farm household level agricultural diversification has always been recognised as a principal risk-reducing strategy. In an effort to secure more stable income streams under risky ecological environments and volatile market conditions, farming households usually employ a mix of ex-ante strategies, with farm level diversification being a principal component in this mix. In the study area, farmers suffer from regular flooding and instability in output prices. Under such conditions however, it is observed that a sizeable proportion of the households practices either very low farm diversification, or is entirely specialised in a single agricultural activity. While income risks faced by farmers in the study area result from varied sources such as production risks, market risks and input risks, in light of the anomaly observed, this study focuses on production risks particularly resulting from flooding, and market risk due to instability in crop prices. An objective of this study therefore is to estimate and analyse the magnitude of these agricultural risks faced by individual farmers, and to relate these findings to the degree of diversification practised. The study utilises Farming Systems Analysis in exploring how living standard of the farming families contribute to the existing degree of diversification. The study also analyses panel data on crop yields and crop prices in ascertaining the level of income risk resulting from production and market variations. Econometric analysis is also undertaken in estimating the impact of cropped land size, diversification degree (estimated by way of the Simpson‘s Index of Diversity), land tenancy arrangement, and the nature of technology employed in production on income. The study then identifies and simulates strategies aimed at reducing farm income variability through the optimising of farm diversification. The findings of these simulations form the basis for recommended strategies at the farm household level.

Keywords: Farming Systems Analysis, Market Risk, Production Risk, Simpson Index of Diversity

Contact Address: Richard Blair, University of Hohenheim, Agricultural Economics and Social Sciences in the Tropics and Subtropics, Fruwirth Strasse 12 70599, Stuttgart, Germany, e-mail: blair@uni-hohenheim.de

Diversification of Livelihood Strategies of Households in Selected Communal Areas in Namibia

UTE SCHNEIDERAT[1], MARIANNA SIEGMUND-SCHULTZE[2], JÖRG STEINBACH[1]

[1] *Justus-Liebig-University Giessen, Department of Livestock Ecology, Germany*

[2] *University of Hohenheim, Animal Breeding and Husbandry in the Tropics and Subtropics, Germany*

Livelihoods of rural households in communal areas in Namibia are constrained by low rainfall amounts, high rainfall variability and low soil fertility. Thus, neither agricultural intensification is an option for livelihood improvement, nor land expansion, which is restricted by the land tenure system. Adequate range management of current resources is actually hampered by changes in access to land because of the weakened control function of traditional leaders. Additionally, the reduction of state subsidies increased the cash demand in Namibian rural areas. Under those conditions, diversification of activities is a strategy to cope with a temporary crisis, minimising risks, and helping to maintain livelihoods in uncertain environments. Embedded within the Biodiversity Monitoring Transect Analysis in Africa (BIOTA-project), this study aims to describe the diverse livelihood strategies of rural communal households in a mixed system in northern Namibia, and two pastoral systems in central and south Namibia. Three community surveys were conducted, covering almost all 70 rural households. Semi-structured questionnaires assessed the productive and socio-economic household situations. Activities of rural households include livestock keeping, crop production, part-time and permanent wage employment, old age pension or other state transfers, social network transfers and small enterprises. Diversification within the agricultural sub-systems covered the keeping of multi-species herds (cattle, goats, sheep, donkeys), or carrying out multi-cropping (millet, sorghum, maize, beans, melons, vegetables). Off-farm incomes, generated via absenteeism (22 % of households) and old age pension payments (48 % of households) were crucial. While livestock keeping was mentioned as the predominant activity by 81 % of the households in the pastoral systems, cattle were hardly ever sold, although about 11 % of the goat flock were sold. In the agro-pastoral system, cattle were sold only in cases of emergency, i.e. yield failure, in order to compensate for food shortage. Infrastructure and the proximity of an urban centre, as well as the harshness of climatic conditions influenced the type of income-sources of these rural households; the education level did not.

Keywords: Communal farming system, diversification, household survey

Contact Address: Ute Schneiderat, Justus-Liebig-University Giessen, Department of Livestock Ecology, Ludwigstraße 21, 35390 Gießen, Germany, e-mail: Ute.Schneiderat@agrar.uni-giessen.de

Supply Response and Competitiveness of Na-Oogst Tobacco Production Analysis in Jember Regency-Indonesia

CIPLIS GEMA QORIAH, HANS MELICZEK
Georg-August-University, Dept. of Rural Development, Germany

Tobacco (*Nicotiana tabacum* L.) is a tall perennial herbaceous flowering plant that belongs to the *Solanaceae* or nightshade family. It is the world's most widely cultivated non-food crop and is chosen by farmers from more than 120 countries because of its performance under widely varying climatic (merely requiring a frost free period of 100–130 days) and soil conditions to meet the demands of many different markets. It also is a plantation commodity that pays high taxes, earns foreign exchange, and employs many workers who earn relatively high incomes. In Indonesia, Voor-Oogst (VO) tobacco is used in producing cigarettes without cigar flavouring and clove cigarettes. Na-Oogst (NO) tobacco is the main material for making big cheroots, cigarillos, and chewing tobacco.

As well as showing a downward trend, Bes-No tobacco prices continue to fluctuate substantially. The world market is quite thin, and a small percentage of over- or undersupply creates large percentage changes in price. This high degree of uncertainty has led to propose for regulations by the Jember government that would reduce the tobacco area.

The Policy Analysis Matrix (PAM) analysis shows that even at reduced prices, tobacco is privately and socially more profitable than the next best alternative, maize. Hence, even though maize is a second food staple, it would not be good public policy to restrict tobacco acreage. The government would perform a useful function if it assisted growers in organising cooperatives that could negotiate prices with tobacco exporters. Providing information about the situation in international tobacco markets at the time farmers are deciding what to plant, would also be a useful government function.

Keywords: Na-Oogst Tobacco, Policy Analysis Matrix (PAM), Supply Response

Contact Address: Ciplis Gema Qoriah, Georg-August-University, Dept. of Rural Development, Hermann Rein Strasse 13 / 102, 37075 Goettingen, Germany, e-mail: c_qoriah@yahoo.com

Conflicts and Stakeholder Involvement

Democracy Models in Non-profit and Economic Interest Groups Involved in Rural-environmental Policy: a Quantitative Analysis

NIKOLAS HASANAGAS[1], ELENI RIGAKI[2], ALEJANDRA REAL[3]

[1]*Technolgical Education Institution of Kavala-Drama, Hellas, Department of Forestry and Natural Environment Management, Greece*

[2]*University of Bochum, Faculty of Philosophy, Germany*

[3]*Georg-August-Universität Göttingen, Institute of Forest Policy and Nature Conservation, Germany*

The patterns of collective action and the process of decision-making gain in research interest in a world which suffers severe poverty problems. The organised participation of people in environmental policy-making through interest groups is decisive for achieving a fair world. But this is only possible if these groups are as "democratic" as possible, namely if the interests they express find the widest possible acceptance and do not serve only political elites or industrial monopolies. The purpose of this article is therefore to contribute to a better understanding of the democracy models found in interest groups. The percentage of qualified members influences the participation of the members in the process of decision-making of their interest group and noticeably determines which type of democracy model takes place within the grou*p. A*ccording to results gathered by a pan-European survey through out the years 2002–2003 — the collected data was afterwards processed through cross-sectional analysis-, non-profit groups have more members with university degrees than economic groups (e.g. federations of enterprises, associations of land owners and entrepreneurs, and syndicates of employees). In the former, the members participate more extensively in the General Assembly but less in the process of Agenda-Setting, while the inverted behaviour is observed in the latter organisations. The former present characteristics of developmental democracy and protective/ competitive elitist democracy in General Assembly and Agenda-Setting respectively, while the latter competitive elitist democracy and participative/ developmental democracy respectively. Advantages and disadvantages of the democracy models, organisational requirements and conditions that support each democracy model are discussed.

Keywords: Democracy models, interest groups, participation

Contact Address: Nikolas Hasanagas, Technolgical Education Institution of Kavala-Drama, Hellas, Department of Forestry and Natural Environment Management, P.Mela 12, 54622 Thessaloniki, Greece, e-mail: nikolashasanagas@yahoo.com

Canopia Project — Humboldt Meets Disney in the Brazilian Amazon

UDO NEHREN, SANDRA ALFONSO

University of Applied Sciences Cologne, Institute for Technology in the Tropics, Germany

The tropical rainforests of the Brazilian Amazon are more than ever threatened by unsustainable land-use practices and overexploitation. The ongoing deforestation and degradation are a serious threat to both the natural and cultural environment in the Amazon itself and the global ecological balance. Initiatives to protect the Amazon rainforest from further devastation have been undertaken for several decades, but many of them failed mainly due to the lack of benefits for local communities. Therefore, strategies integrating environmental requirements into economic and social needs have been formulated. Most of them are based on the economic and social values of biodiversity. Ecotourism is a promising alternative to benefit directly from biodiversity, because of its high economic potential and good prospects in the long term. On the other hand, there are ecological and cultural risks, particularly when tourism development expands into remote areas. To minimise those dangers, the needs of local communities and the interests of investors and other stakeholders have to be considered and weighed against each other. Against that background, the presented pre-feasibility study for the "CANOPIA-Project" analyses the possibilities of combining scientific research in tropical rainforests with ecotourism. The innovations of the project are the scientific orientation in the field of canopy science, using extraordinary observation systems such as cranes and balloons to study the hidden world of forest canopies, as well as the unique project concept. The latter is based on the hypothesis that it is possible and profitable to establish a large scale ecotourism project with a minimum capacity of 200 beds, which

- allows tourists to explore the forest canopies with cranes, trams, etc.,
- gives them the opportunity to observe scientists during their work,
- supports scientific research activities through profits from tourism,
- encourages the development of a region with structural difficulties,
- creates a local market for high value agricultural products and
- helps to protect a rainforest area.

To find out if and how such a project could be realised in the Brazilian states of Amazonas or Pará was the aim of the study.

Keywords: Amazon Rainforest, Canopy Science, Ecotourism, Regional Development

Contact Address: Udo Nehren, University of Applied Sciences Cologne, Institute for Technology in the Tropics, Betzdorfer Str. 2, 50674 Cologne, Germany, e-mail: udo.nehren@web.de

Socio-economic Development of Indigenous People in Three Different Environments in Pernambuco, Brazil

ÁUREA FABIANA APOLINÁRIO DE ALBUQUERQUE, WERNER DOPPLER
University of Hohenheim, Farming and Rural Systems in the Tropics and Subtropics, Germany

Indigenous people in the Amazon rainforest are often in the focus of international interests. Socio-economic research in this zone has shown difficulties in getting adequate information from those traditional systems. Areas and indigenous societies in the Pernambuco State have been selected since the contacts to the outside world exist and would allow better information for research. The main problems these societies face are the increasing pressure for land from outside people, small connection to the monetary system and market and certain crises of tribal identity. Three different indigenous groups have been selected which differ in their ecological and economic environment and hence, show different relations to the outside world and economic development. The objective of the study is to analyse the socio-economic development of indigenous people in and changing environment and to assess the future potential for a sustainable socio-economic development in the frame of the cultural settings. The indigenous families were classified according to their different ethnic features and different environmental conditions. Indigenous families were randomly selected and interviewed. The methods adopted in this study were the Farming Systems Approach to describe and analyse the socio-economic settings of the indigenous families, and a comparative analysis between the three farming systems to track down differences in resource capacities, problems and impacts. The current results denoted that the closer the indigenous are to the urban centres, the higher the off-farm income and the higher the tendency to re-allocate indigenous family work to off-farm activities. Those living in the arid zone have lower farm income and living standard than in the other ecological environments. There are indications that irrigation in the highly erratic rainfall areas could improve the farm income if market relations can be developed.The perception of the different ethnic groups indicate a close relation to traditional behaviour and culturally based decision-making. Three strategies are interesting for testing using simulation models: **(1)** water resource development, **(2)** changes in credit conditions and **(3)** introduction of less-water intensive crops.

Keywords: Brazil, farming systems, indigenous people, living standard, socio-economic development

Contact Address: Áurea Fabiana Apolinário de Albuquerque, University of Hohenheim, Farming and Rural Systems in the Tropics and Subtropics, Institut 490c, University of Hohenheim, 70593 Stuttgart, Germany, e-mail: aureaalb@uni-hohenheim.de

Resources Management and Effective Co-operation of Organisations in Amazonia: A Discussion on the Social Component of Recycling in the City of Belém

ARIMAR LEAL VIEIRA[1], MARCOS XIMENES PONTE[1], ANTONIO CARLOS REIS DE FREITAS[2], REBEKKA KUBISCH[3]

[1]*Federal University of Pará, NAEA, Brazil*

[2]*Brazilian Agricultural Research Corporation (EMBRAPA), Embrapa Mid-North Agriculture, Brazil*

[3]*Johann-Wolfgang-Goethe-University Frankfurt, Institut für Molekulare Biowissenschaften, Germany*

This paper aims to understand the organisation process of recycling in Amazonia through the discussion of the social components of the sorting collection system mainly conducted by former farming families in the city of Belém. In the middle of the 70's, the Brazilian Amazon region faced several problems related to the implementation of large industrial and agricultural projects. Consequently, this situation caused mismanagement of natural resources, rural conflicts and loss of land used by farming families in some rural areas of the state of Pará. This unfavourable condition encouraged a process of migration of these families to Belém. Furthermore, due to the lack of opportunities in the formal labour market in the city, these families were forced to collect recycling materials, as scavengers, in order to earn their living. A broad understanding of this issue involves the relationships among different groups as well as the social-economical situation of these actors. To support this research, an interdisciplinary study was conducted mainly based on the fields of Industrial Ecology (IE), Theory of Groups, Cost-Benefit Analysis (CBA) and anchored by a Life Cycle Assessment (LCA). Life Cycle Assessment (LCA) is known as a promising tool for environmental management. In order to contribute to the discussion of LCA, as well as its application field, this study also intends to include the social component in its scope, through the analysis of the agents that act in the recycling of aluminum cans. Finally, the results show the current benefits of the sorting-collection system, indicating the gains through the organised groups which, in final statement, takes place by means of the effective co-operation among the actors.

Keywords: Farming families, life cycle assessment, recycling, social component, theory of groups

Contact Address: Arimar Leal Vieira, Federal University of Pará, NAEA, Av. Augusto Correa s/n, 66055-000 Bélem, Brazil, e-mail: arimarlv@yahoo.com.br

Palatability Comparison of Woody Capoeira and Forage Legume Species in a Cafeteria Trial in the Eastern Amazon

STEFAN HOHNWALD[1], ARI PINHEIRO CAMARÃO[2], JOSÉ ADÉRITO RODRIGUES FILHO[2], CLEMENS WOLLNY[3]

[1]*Georg-August-University Göttingen, Institute of Animal Breeding and Husbandry in the Tropics and Subtropics, Germany*

[2]*Brazilian Agricultural Research Corporation (EMBRAPA), Brazil*

[3]*International Livestock Research Institute, (ILRI), Ethiopia*

In north-eastern Pará, extensive pasture production on smallholdings shows low performance, and pasture improvement strategies, e.g. the use of forage legumes, have been hardly adapted. One reason for low performance is the re-sprouting secondary vegetation, locally called "capoeira". However, recent studies showed that a lot of these capoeira species are intensively browsed by cattle, so that it was anticipated that the phytodiverse capoeira might still include some interesting supplementary forage species. Thus, the 10 most palatable and frequent capoeira species are tested against known promising forage legume species, in this study. Therefore, an on-farm cafeteria trial is conducted on a 0.5 ha *Brachiaria brizantha* pasture at Igarapé-Açu (47º36´W/1º08´S). Six capoeira species, namely *Attalea maripa* (Arecaceae), *Banara guianensis* (Flacourtiaceae), *Cecropia palmata* (Cecropiaceae), *Neea oppositifolia* (Nyctaginaceae), *Phenakospermum guianensis* (Strelitziaceae), *Solanum juripeba* (Solanaceae), and the three forage legumes *Calliandra calothyrsus*, *Cratylia argentea*, *Flemingia macrophylla* plus the P-mobilising *Tithonia diversifolia* (Asteraceae) were chosen and planted in 5×5 m subplots with 25 plantlets, each. These unfenced treatments were replicated five times in a randomised block design on the pasture plot. As control, three randomised ungrazed subplots of each species were planted outside the plot (n=80 subplots, 2000 forage plantlets). The pasture will be grazed by mixed-bred steers at 2 LU ha^{-1} in the first year, by sheep at 15 LU ha^{-1} in the second, and by buffaloes at 1.5 LU ha^{-1} in the third year, both during rainy and dry seasons (=600 kg ha^{-1}, each year). Browsing damages, relative growing performance, relative consumed biomass, and "in vitro" digestibility of the each species will be compared. The study will show if palatable native capoeira species can be recommended as an alternative to commercially forage legume species. As these species are commonly found on smallholdings and well adapted to the ecosystem, the farmer might have low-cost alternatives for forage production.

Keywords: Animal production, Brazil, browsing, buffaloes, cattle, secondary vegetation, sheep

Contact Address: Stefan Hohnwald, Georg-August-University Göttingen, Institute of Animal Breeding and Husbandry in the Tropics and Subtropics, Kellnerweg 6, 37077 Göttingen, Germany, e-mail: shohnwa@gwdg.de

Endogenous Poverty Assessment as a Contribution to Pro-poor Oriented Research Design — A Case Study in Potato-producing Communities in the Central Highlands of Peru

GISELA GLIMMANN[1], ANDRE FABIAN[1], JÜRGEN KROSCHEL[2], SIMONE SEHER[1], EILEEN GEHRKE[1], IVONNE ANTEZANA[1], SIMON FREUND[1]

[1]*Humboldt University Berlin, Centre for Advanced Training in Rural Development (SLE), Germany*

[2]*International Potato Center, Integrated Crop Management Division, Peru*

The International Potato Center (CIP) seeks to reduce poverty and achieve food security in developing countries through scientific research and related activities on potato, sweetpotato, and other Andean root and tuber crops. The CIP's 2003-vision exercise paved the way for a more consequent orientation of the Center's research towards pro-poor impacts and contributing effectively to the Millennium Development Goals.

The objective of the present study was to contribute to a better understanding of what poverty or well-being for small-scale farmers means and how farmers perceive potato production in the context of poverty alleviation, and inform institutions to plan future interventions. Therefore, the degree, dynamics and causes of poverty in four potato producing Andean Highland communities of Peru were assessed. This was achieved through the "Participatory Approach to Poverty Assessment" (PAPA), which has been developed as a multidimensional approach aiming at capturing farmers' own concepts about poverty-related factors and opportunities for improving the living situation, including the role of non-tangible assets e.g., social support. The study illustrates that well-being of households is associated to a diversified, market-oriented agricultural production strategy, to access to institutions for the provision of information, technologies, inputs or credit, to income diversification and to social support within the communities. The intensification of potato production is an important strategy to improve livelihood, especially if farmers got access to markets. The study revealed that agricultural support measures are often selectively applied, mostly to best-educated farmers; in contrast, poorer households have less access to agricultural support and often have different needs.

The study concludes that holistic interventions are needed taking into account the heterogeneity of poverty causes. A pre-intervention assessment, e.g. through PAPA, which mirrors the endogenous perception and necessities at community and individual level, could serve as a basis for targeting research and development activities. As a consequence, conducting participatory research and disseminating results would support the community aspiration contributing more effectively to poverty alleviation.

Keywords: Institutional learning, Pro-poor targeting, potato production

Contact Address: Gisela Glimmann, Humboldt University Berlin, Centre for Advanced Training in Rural Development (SLE), Hessische Str. 1-2, 10099 Berlin, Germany, e-mail: gisell23a@hotmail.com

Community Decisionmaking Participation and Collaborative Management in Ecotourism Development - A Case Study in Tangkahan, North Sumatera

PINDI PATANA[1], RENATE BÜRGER ARNDT[2]

[1]*Georg-August-University Göttingen, Tropical and International Forestry, Faculty of Forestry, Germany*

[2]*Georg-August-University Göttingen, Forest Policy and Nature Conservation, Germany*

Generally active local participation in decisionmaking is a precondition for benefits reaching communities. In developing countries, however, this paradigm is difficult to put into practice owing to various constraints. Based on a study in the Tangkahan, Leuser National Park, it is demonstrated that long decisionmaking processes as radical step to set up the view how the local community can benefit sufficiently from tourism rather than destructive activities such as illegal loggers. Thus, to have a say in the management area is only one of many ways to ensure that local people benefit from ecotourism. Rather, the modes of participation are related to the institutional arrangements and the different stages of tourism development present in a community. Management of natural resources surrounding national park faces many problems, especially when it related into land tenure system and benefit shared among parties. Conflict of interest often rise into different stage of many stakeholders due to lack of forest regulation, top down approach and law enforcement. As a new destination in North Sumatra, Tangkahan is an interesting alternative to the famous Bukit Lawang orangutan rehabilitation centre. There is no such rehabilitation centre, but the location is definitely more remote and far from beeing as touristy as Bukit Lawang. The villagers of Tangkahan try to participate in the integration of their own subsistent livelihoods into the local economy. Illegal logging was common until three years ago. Then, illegal loggers from local villages (2000 household) were convinced to use ecotourism as a tool for increasing an alternative income besides farming. At this point however the ex-loggers expectations are not metdue to a lack of promotion and a low standard of products and services to meet visitor satisfaction (IUCN, 2004), the Park only attracts small visitor numbers.

Keywords: Collaborative management, community participation, decisionmaking, ecotourism, North Sumatera, Tangkahan

Contact Address: Pindi Patana, Georg-August-University Göttingen, Tropical and International Forestry, Faculty of Forestry, Hermann-Rein-Strasse 13/app.101, 37075 Goettingen, Germany, e-mail: pindi_patana@yahoo.com

Agropastoral Conflicts in the North West Province of Cameroon

PROSPER FUAMBENG YONGHACHEA, LINDSEY NORGROVE, RAINER SCHULTZE-KRAFT

University of Hohenheim, Biodiversity and Land Rehabilitation in the Tropics and Subtropics, Germany

Conflicts between sedentary farmers and transhumant pastoralists are common in sub-Saharan Africa. In recent years these have often been large scale, the most notable involving large migrations from Nigeria into Adamouwa Province in Cameroon in January 2002. Such conflicts regularly involve the use of guns and machetes as weapons, killing of cattle, and the intentional destruction of farmers' property (fields, plantations, granaries). In May 2005, a serious agropastoral conflict occurred in Wum, North West Province of Cameroon. The climax vegetation of Wum is forest - savannah transition; however most of the forest has been already converted to agriculture. The economy of Wum depends on crop and livestock production. The Wum population comprises two distinct ethnicities: the autochthonous sedentary Aghem ethnicity, who are the majority, and the Fulbe pastoralists, who herd cattle. The Aghem cultivate predominantly maize, cocoyams, sweet potatoes, cassava, beans, cowpea and groundnuts. In Wum, the Fulbe have diversified their traditional pastoralist lifestyle to include farming. Their main crops include: maize, cocoyams and chili pepper and on average now have more than three times more crop land per household than the Aghem (9.5 ha compared with 2.5 ha), which was obtained in previous negotiations with village chiefs. While the root of the conflict might be that the Fulbe now compete directly with the Aghem in crop production, the trigger for the conflict was the claim by the latter that the Fulbe do not control and prevent their cattle from destroying Aghem crops so the Aghem retaliated and impounded the Fulbe cattle and asked for large ransoms for the cattle to be released. The local council suffered the effects of no slaughter houses and no cattle market since the council derived most of it revenues from the grazers. The council decided to levy a tax on all cattle that had to pass through Wum to the neighbouring villages. The conflict has still not been resolved. The implications of this conflict on food security and land use in Wum are discussed.

Keywords: Agropastoral conflicts, Cameroon, food and cattle production

Contact Address: Prosper Fuambeng Yonghachea, University of Hohenheim, Biodiversity and Land Rehabilitation in the Tropics and Subtropics, University Hohenheim, 70593 Stuttgart, Germany, e-mail: prosperfy@yahoo.co.uk

Land Competition Between Farming Systems and a Biodiversity Paradise in the Central Atlantic Rainforest of Brazil

HARTMUT GAESE[1], MARC J. J. JANSSENS[2], RUI PEDROSO[1], SABINE SCHLÜTER[1], JUAN CARLOS TORRICO[2]

[1]*University of Applied Sciences Cologne, Institute for Technology in the Tropics, Germany*

[2]*University of Bonn, Institute of Crop Science and Resource Conservation - Tropical Crop Production, Germany*

The mountainous hinterland of Rio de Janeiro is the habitat of the Atlantic Rainforest, characterised by a potentially dense forest of rich biological diversity. The hilly upland forms a highly fragmented agricultural landscape with a very few forest fragments . Land use is dominated by extensive cattle farming systems and small ruminants on marginal land (60 % of the same State) and by intensive, thriving horticulture farming systems on the adjacent flatlands, irrigated from water sources mostly originating in the surrounding forested hills. This enables intensive production of leafy vegetables. Farming systems have been analysed within a Brazilian-German research cooperation, the BLUMEN project. A detailed survey was conducted in the municipality of Teresopolis, within the Preto river basin at an altitude between 700–1000 m above sea level among crop and animal farmers. About 83 % of the farms are family owned and 51.3 % are less than 10 ha in size. These smallholdings occupy only 6.7 % of the cultivated area, whilst farms larger than 150 ha cover the largest portion (36.6 %) of the cultivated area.

Crop land and range land compete with preservation and reforestation strategies. Degradation of land is a mean feature of the municipality. Testimonies suggest that in the last 50 years water discharges have decreased up to 50 %, due to deforestation and to the loss of many small water springs (1/6 in this survey). The Rio Preto is polluted with agro-chemicals residues.

Cattle husbandry based on a local Mestizo breed, is done by the vast majority (76 %) of the surveyed farmers. Sheep, goat and horse husbandry rank in a secondary position. Cattle farmers prefer cattle breeding (61 %), to beef cattle (22 %) and lastly to milk cattle (17 %). Although stocking rate approximates 0.7 ha/TLU, paddock rotation is rarely practised. Average weight increase is only 350 g/head/day. Stabled husbandry of goats and sheep shows better levels of sustainability. Horse breeding is usually carried out for recreation, showing high levels of investment and underlining the tourism potential of the region.

It is concluded that preserving, if not improving, 20 % (say 8 % for the whole of Mata atlantica) of total land with fragmented biodiversity paradises can only be achieved by increasing agrodiversity elsewhere whereby tree crops could play a buffer and connecting role.

Keywords: Brazil, farming systems, land degradation, land use, Mata atlantica

Contact Address: Hartmut Gaese, University of Applied Sciences Cologne, Institute for Technology in the Tropics, Betzdorfer Straße 2, 50679 Köln, Germany, e-mail: hartmut.gaese@fh-koeln.de

Socioeconomic Contrasts of Colonisation and Utilisation of the Brazilian Cerrado

CARLOS MAGRI FERREIRA[1], PATRICIO MENDEZ DEL VILLAR[2], ALCIDO ELENOR WANDER[1]

[1]*Brazilian Agricultural Research Corporation (EMBRAPA), National Rice and Beans Research Center (CNPAF), Brazil*

[2]*French Agricultural Research Centre for International Development (CIRAD), Annuals Crops Department, France*

The Brazilian central region has an agricultural potential of more than 40 million hectares. This potential is concentrated in the Cerrado. During 2003 crop season, considerable amounts of agricultural products came from this region. The produced amounts reached 27.15 million tons of soybeans (48.1 %), 13.81 million tons of maize (27.5 %), 2.03 million tons of rice (19.6 %), 0.83 million tons of beans (28.2 %), 2.40 million tons of cassava (10.9 %) in 2003 seasons. Additionally, there were stocks of 7.51 million of cattle (3.8 %), and there were produced 44.3 million liters of cow milk (33.7 %). The percentages in parentheses represent the participation in national production. This development of production in the region was obtained with the adoption of technology adapted to the region and brought benefits like the development of the Cerrado. However, in its course there occurred some undesirable effects like increasing in land prices and coming up of social conflicts and environmental imprudences. Secondary data on rice production and cultivation area for 1990 to 2003 in the municipalities located in the Brazilian Cerrado were obtained from the Brazilian Institute of Geography and Statistics and statistically analyzed. In this study three different situations were identified: **(a)** areas of strong agriculture enterprises, with higher production density and high yield levels; **(b)** areas with traditional agriculture, which is getting under pressure of the strong agricultural enterprises; and **(c)** less developed areas, where extensive ranching and cropping at low technological level are being practised. A zoning of these three situations was done with geographic information system tool MapInfo Professional. Finally, the study points out some social and environmental threats and present proposals and challenges for agricultural research and public policies to seek for a more equilibrated development for the Brazilian Cerrado region.

Keywords: Brazilian savannah, development policies

Contact Address: Alcido Elenor Wander, Brazilian Agricultural Research Corporation (EMBRAPA); Federal University of Goias (UFG); Faculdades Alves Faria (ALFA), Rodovia Goiania a Nova Veneza, km 12, 75375-000 Santo Antonio de Goias, Brazil, e-mail: awander@cnpaf.embrapa.br

Processes and Disparities in the Cambodia Agricultural Sector

MUND JAN-PETER[1], BUNTHAN NGO[2]

[1]*Royal University of Agriculture, Phnom Penh, Department of Land Management and Land Administration, Cambodia*

[2]*Royal University of Agriculture, Phnom Penh, Department of Agricultural Technologies,*

Agriculture plays the most important role in Cambodian society by ensuring food security at community and national level. Although Cambodia has achieved overall national rice self sufficiency with a very small surplus at the national level since 2000, there are still regional and local deficit regions, in particular in remote rural areas on unsuitable soils. A growing number of families are not able to survive on their own rice production, especially in the areas affected by the worst floods in the Mekong floodplain in 2000 and 2001 or irregular severe drought on poor sandy soils in 2004–2005. Cambodian agriculture is still remarkably undiversified with more than 2.3 million ha planted with rice only and no significant robust growth in the agricultural sector over the past five years.

Today, processes of land occupation and land use change intensify the challenges in ensuring food security, especially in recently cultivated upland regions. Current population dynamics are driven by land occupation and land shortage in the lowlands. Land use planning issues and economically motivated large scale land distributions characterise growing disparities and transitions in the agrarian sector. Continuous intervention of the state into land regulations, ownership policy, land use planning measures and distribution of land use rights to large scale agro-industrial investors illustrate the Cambodian practise. Comparing Cambodia to other South East Asian countries the agrarian question concentrates primarily on the dispute whether or not concentration of land ownership is indispensable for a full capitalist transition into a modern economic agriculture. Land and access to land became one of the most crucial factors in Cambodian agriculture since 1991, when Cambodia transferred its collective economy into a modern market economy. Nevertheless, predominant agrarian strategies for small farmers as well as economic investors are exploitations and even over-exploitations of natural resources with little investment into sustainable production. As a result, the Cambodian government's goal to reduce rural poverty will not be successful without a more rapid and sustained agricultural growth including poor and landless small-scale farmers.

Keywords: Agricultural development, cambodia, Disparities, Food security, Land concessions

Contact Address: Mund Jan-Peter, Royal University of Agriculture, Phnom Penh, Department of Land Management and Land Administration, GTZ Main Office Phnom Penh, Phnom Penh, Cambodia, e-mail: jpmun03@yahoo.com

Checklist for Agricultural Adaptive Research in Drylands — How to Identify Synergies and Avoid Conflicts Between Competing Aims of Sustainable Development

KATRIN VOHLAND[1], MARIAM AKHTAR-SCHUSTER[2]
[1]*University of Potsdam, Vegetation Ecology and Nature Conservation, Germany*
[2]*University of Hamburg, Biocentre Klein Flottbek and Botanical Garden, Germany*

The formulation of the United Nations Millennium Goals (MDGs) is the most human-focused approach of the UN international commitments and contracts of the UN for maintaining and enhancing human well-being on the basis of an intact environment and sustainable development. It was acknowledged that the most important sector for action to achieve the MDGs is rural development, including availability of food and water, sanitation and education. However, during the formulation of scientific projects as well as during their implementation phase, the MDGs as well as the cultural, social and economic realities in the target areas are often only insufficiently regarded. One of the main reasons is the lacking awareness in the research community that participation should already start with the problem formulation. Other important reasons that counteract food security are conflicts between the different aims of national and international scientific programmes and the UN Conventions to achieve sustainable development. Enhancing biomass production is one of the main sub-goals always present when improving agricultural and environmental conditions is. This is seen as a pathway to increase crop production and fuel material as well as to safeguard biodiversity. However, conflicts might arise when using GM crops or exotic species. Afforestation especially of wetlands may in some cases increase water consumption above a sustainable level. Further, the conservation of carbon stocks is not accounted for in the Kyoto protocol and therefore often ignored in discussions on sustainable land use practices. On the other hand, the tight relationship between environmental protection and rural development is widely acknowledged, and synergies occur between different measures for sustainable development e.g. in the field of improving water use efficiency by means of rain water harvesting technologies. In order to raise the awareness of the need of sound relationships between the needs and the aims of the local people, the international aims and actions for sustainable development, and the agricultural research projects, we would like to present and discuss a checklist to detect competing sub-goals and to transform them into synergy processes in order to reach the MDGs.

Keywords: Biodiversity, food security, UN conventions

Contact Address: Katrin Vohland, University of Potsdam, Vegetation Ecology and Nature Conservation, Maulbeerallee 2, 14469 Potsdam, Germany, e-mail: katrin.vohland@web.de

The Limits of Collaborative Management Board in Lore Lindu National Park, Indonesia

TANTY S. THAMRIN

Georg- August University, Göttingen, Agriculture Faculty, Natural Resource Program, Germany

This paper seeks for an empiric experience of the stakeholder to see the limits of Collaborative Management model that build in Lore Lindu National Park, and to have a clear understanding about weakness, and opportunities for Collaborative Management Board in Lore Lindu National Park. This paper analyses the limits of Collaborative Management Board, as one of the Collaborative Management models that build in Lore Lindu National Park. As it is understood, the Collaborative Management (Co-management) Board in Lore Lindu National Park is one of the stakeholder efforts (individual and groups) who are concerned with sustainable natural resources, social justice and enquiry, and community-based initiatives to minimise the conflict over natural resources in the park. The result presented on the paper are based on SWOT (Strengthening — Weakness — Opportunity — Threatening) analysis, interviewed with the Head of Lore Lindu National Park Authority Management, FKTNLL coordinator, government and interviews with NGOs who work in Lore LIndu National Park, as well as analysis of reports, both published and available in World Wide Web. Since 2002, Collaborative Management models have been started in Lore Lindu National Park. The model is based in three main reasons. First, the communities needs on access and control to the natural resources surround them. Second, sharing the "strength stakeholders" controls over natural resources management. Third, accommodate the stakeholder's needs and interest. In Lore Lindu National Park case, "the stakeholder's strength" is government, private sectors, NGOs and researchers. Collaborative Management is a pathway to give more opportunity to solve the problems for both communities and stakeholders. To maximise the effort, it is important to understand that Collaborative Management Board might have its limitation. The knowledge and understanding of the limits will keep the stakeholders and social actors aware and prepare to anticipate the limits to reach the best results.

Keywords: Collaborative Management, Interest. , Stakeholder, stakeholder Analysis, SWOT Analysis

Contact Address: Tanty S. Thamrin, Georg- August University, Göttingen, Agriculture Faculty, Natural Resource Program, Christophorusweg 12 App. 7, 37075 Göttingen, Germany, e-mail: tantysthamrin@yahoo.com

Globalization and Liberalization

Agricultural Research Needs in a Globalized World: Method Improvement

OGHAIKI ASAAH NDAMBI, KHALID MAHMOOD, OTTO GARCIA
IFCN Dairy Research Center, Germany

Economic evaluation of farming systems in developing countries is very complex and subject to error as rural farmers do not keep records. Most researchers and students have diverse opinions, leading to the use of several methods in farm analysis. As such, difficulties arise in comparing results, since assumptions differ in each method. There is therefore a great need for a globalised method for farm analysis. The TIPI-CAL (Technology Impact and Policy Impact Calculations) model was developed by the IFCN (International Farm Comparison Network) and is method that can stand global applications. This model has an advantage of revealing feasible economic situations under given farm conditions, thereby exposing irrelevance and allowing for checks on the validity of submitted data.

Raw data was collected from typical dairy farms in Cameroon, using in-depth interviews. Data which had previously been analysed using Excel without the model was re-analysed using the TIPI-CAL model. The model enabled a precision in data input of vital elements of cost and revenue such as mortality rates, annual milk yields, opportunity costs and depreciation costs. The separation and measurement of dairy inputs and revenues from those of the whole farm was also plausible with both small and large farms, thereby enabling the model applicable in small-scale farming systems as well. From comparison of the two methods we found that, the TIPI-CAL model revealed significantly higher total costs of production as well as the total income generated from dairy production than the former method. It was realised that, the profit, though still low, appeared double when all cost and benefit components (cash and non-cash) were included in the model calculations. This internationally accepted methodology helped in clarifying doubts from previous studies, which questioned why farmers remained motivated in production, despite the low cash profits they obtained. In addition, this method allows the comparison of production systems at regional, national and international levels.

Keywords: Farm analysis, Globalisation, International comparison, TIPI-CAL model

Contact Address: Oghaiki Asaah Ndambi, IFCN Dairy Research Center, Bohlweg 55, 38100 Braunschweig, Germany, e-mail: ndamboa@yahoo.com

The Influence of Globalisation on Livestock Biodiversity and Farmer Livelihoods: Implications for Future Policy and Research

ADAM DRUCKER[1], SIPKE-JOOST HIEMSTRA[2], NIELS LOUWAARS[2], J.K. OLDENBROEK[2], M.W. TVEDT[3]

[1]*Charles Darwin University, School for Environmental Research, Australia*

[2]*Wageningen University and Research Centre, Centre for Genetic Resources, The Netherlands*

[3]*Fridtjof Nansen Institute, Norway*

Improving the livelihoods of poor livestock-keepers is a key means of reducing poverty and food insecurity. Attaining such livelihood improvements requires the conservation and sustainable use of livestock diversity, as animals of different characteristics, and hence outputs, suit differing local community needs, markets and agroecosystems . In the context of approximately 30 % of the world's farm animal genetic resources (FAnGR) being at some degree of risk of extinction, there has been a steadily growing debate on the need for a legal framework and other options to deal with access, exchange and conservation of FAnGR. Exploring such options through an analysis of the current situation and a range of future projections to 2050, reveals that the livestock sector has been and will continue to be influenced by, among other factors, the process of globalisation. The three main drivers behind such globalisation trends are related to a continuation of the "livestock revolution", human population growth, urbanisation and increasing affluence in the South. They include: (1) a rapid worldwide increase in consumption and production of livestock products, with a major increase in the share of developing countries in total consumption and production, (2) a continuation of ongoing changes in the status of livestock production from a multipurpose activity with mostly non-tradable output, to food and feed production in the context of globally and/or regionally integrated markets, (3) an emergence of rapid technological change in livestock production and processing in industrial systems. With particular regard to the impact of globalisation on FAnGR and poor farmer livelihoods, the full paper discusses these drivers in greater detail, together with the need for policy and research to support smallholders. The need for such work to include the development of national policies or international instruments which could facilitate or regulate international exchange while helping to avoid negative impacts is also explored.

Keywords: Farm animal genetic resources, globalisation, livelihoods, smallholders

Contact Address: Adam Drucker, Charles Darwin University, School for Environmental Research, Elengowan Drive, 0810 Darwin, Australia, e-mail: adam.drucker@cdu.edu.au

Should Small-scale Dairy Farmers Welcome Globalisation?

OTTO GARCIA, KHALID MAHMOOD, OGHAIKI ASAAH NDAMBI
IFCN Dairy Research Center, Germany

Globalisation means an ever-changing economic climate, in which challenges and opportunities come at you from every side. In such a competitive global situation, the first thing is to assess how small-scale farmers are positioned to convert challenges into opportunities, which they can capitalize on.

This study main objective was to evaluate how small-scale dairy farmers in selected developing countries produce milk as compared to their counterparts in several industrialised nations. The measurement of cost of milk production is taken as the indicator for global competitiveness. It is assumed that the lower the production costs for a liter of milk, the better positioned a farmer is to compete in a global market.

This study uses the methodology and database of the International Farm Comparison Network (IFCN) to analyse typical dairy farming cases in India, Pakistan and Peru (as developing countries) and Germany, United States, and Australia (as industrial nations). The IFCN methodology relies on panels of local dairy experts (3–6 people), who assist in selecting the farming cases, revise the data collected and validate the results of the economic analyses.

The results of this comparative study show that small-scale farmers in developing countries are low-cost producers. This positions subsistence dairy farmers on solid grounds to exploit the poverty reduction benefits inherent in globalisation. However, these small-scale farmers are quite clear that, although they can produce milk competitively, their ability to successfully operate in a globalised world depends on a set of conditions such as **(1)** having working capital for growth and intensification, **(2)** counting with reliable and remunerative markets, and **(3)** availing affordable quality livestock services. Finally, small-scale dairy farmers in these countries would very much welcome globalisation once conditions of a well-managed global trade complement their global leadership as low-cost producers.

Keywords: Dairy, globalisation, IFCN, Milk Production, Poverty

Contact Address: Otto Garcia, IFCN Dairy Research Center, Bohlweg 55, 38100 Braunschweig, Germany, e-mail: otto.garcia@ifcndairy.org

Globalisation May Bring Prosperity to Subsistence Dairy Farmers in Developing Countries

KHALID MAHMOOD, OGHAIKI ASAAH NDAMBI, OTTO GARCIA
Federal Agricultural Research Centre (FAL), IFCN Dairy Research Center, Germany

Half of the world, nearly 3 billion people are living on income less than US$ 2 per day. Of these, an estimated 798 million people suffer from chronic hunger, which means that their daily in take of calories is insufficient to lead an active healthy life. Milk is an important food resource which is rich in protein and vitamins. In order to meet the WHO standard of daily intake of milk as 120 grams per head, we need 750 million tonnes of milk annually but there is a shortage of 150 million tonnes each year, mostly in developing countries. The question is: who shall fill this gap in production? a) Industrialized countries exporting to the developing countries, b) Developing countries them selves.

For this study data is collected from typical dairy farms through setting up a panel of experts from developing countries and industrialised countries. The countries selected are India, Pakistan, Germany and USA. The methodology of the study uses the concept of typical farms developed by IFCN (International Farm comparison network) method.

The analysis shows that subsistence farmers are in better position to produce milk on lower production costs as compared to industrialised countries. The difference in cost of milk production is up to 50 percent in most of the cases. The cash costs of subsistence farms are relatively a lot lower which are only 20 percent of the cash costs of industrialised countries. The main difference of this lower cash costs comes from the feeding and management practices. Feeding systems in developing countries are more based on feeding by-products of crops and roughages which are very cheep as compared to grains and concentrates in industrialised countries.

The study concludes that developing countries have the higher potential to fill the gap in milk production on lower costs as compared to industrial countries. As subsistence farmers are feeding roughages, utilising the family labour and simple technology. The subsistence farmers can only achieve this target if the conditions of livestock services to improve the animal health, easy access to loan for buying inputs for the farm and access to competitive market

Keywords: IFCN, milk gap, poverty, production system, subsistence, WHO

Contact Address: Khalid Mahmood, Federal Agricultural Research Centre (FAL), IFCN Dairy Research Center, 55-Bholweg, 38100 Braunschweig, Germany, e-mail: khalid.mahmood@fal.de

Adoption and Impact of Eurepgap Standards: the Case of Kenyan Smallholder Export Farmers

SOLOMON ASFAW[1], HERMANN WAIBEL[1], DAGMAR MITHÖFER[2]
[1]*University of Hannover, Development and Agricultural Economics, Germany*
[2]*International Centre of Insect Physiology and Ecology (ICIPE), Kenya*

Despite the success of the horticulture industry in Kenya to which many smallholder farmers contribute, producers are facing new challenges related to changes in the structure of consumer demand and the transformation of the food retail market in Europe. European Union (EU) retailers increasingly ask for produce certified according to food safety and quality standards. The European Retailer Protocol for Good Agricultural Practices (EurepGAP) is the most widely known example of a common EU supermarket standard. Though it is a private standard, it is regarded as a condition of entry to EU markets and is unlikely to provide price premiums. Compliance to these standards for smallholders entails costly investments in variable inputs (in particular the switch to approved pesticides) and long-term structures (e.g. grading shed, charcoal cooler, disposal pit and pesticide store). These investments are "lumpy" and mostly specific to the fresh export vegetable business. It is questionable whether small-scale farmers have the resources and skills to comply with standards and the cost of implementing these standards may drive producers out of lucrative fresh export business.

This article addresses three major objectives: **(1)** to investigate the nature, magnitude and significance of cost of compliance with EurepGAP standards, **(2)** to examine factors explaining the smallholder decision to adopt EurepGAP standards among which cost of compliance can be expected to be a major one and **(3)** to assess the impacts of EurepGAP standards on smallholder welfare. Analysis is based on a random cross section sample of 439 small-scale export vegetable producers in Kenya whose production was monitored in 2005/2006. To account for self-selection as a source of endogeneity we use the two-stage standard treatment effect model. The first stage consists of the adoption decision model for the adoption of EurepGAP standards and the second stage is the impact model that provides estimates of the impact of adopting EurepGAP standards on farm net-income.

Keywords: Adoption, eurepGAP Standards, Export vegetables, Impact, Smallholder

Contact Address: Solomon Asfaw, University of Hannover, Development and Agricultural Economics, Königsworther Platz 1, 30167 Hannover, Germany, e-mail: solomon@ifgb.uni-hannover.de

Impacts of the Liberalisation of Agricultural Research and Extension on Multi-functional Agriculture in Banikoara, Benin

ISMAIL MOUMOUNI MOUSSA
Humboldt-University Berlin, Rural Sociology, Germany

The assessment of the performance of agricultural services for sustainable poverty alleviation in the context of globalisation and liberalisation should take the multi-functionality of agriculture into consideration. This multi-functionality forces to an interdisciplinary analysis of the impacts of the liberalisation of research and extension on agriculture. This paper aims at investigating the impacts of the withdrawal of the state and the involvement of private stakeholders, NGOs and farmer organisations in delivering and financing research and extension on the farming for subsistence and income, the social cohesion and collective action, the agriculture as source of prestige and the environment protection in Banikoara. Semi-structured interviews were carried out with local government leaders and workers of public research and extension organisations, development projects, the district farmer organisation and NGOs in Banikoara district. The study provided the evidence that the liberalisation of agricultural research and extension in Benin tends to **(i)** orient farmers towards the production of cash crops to the detriment of food availability and quality, **(ii)** destroy the social cohesion through the dismemberment of families, tensions and conflicts in villages, and **(iii)** damage the environment. However, its impacts on the agriculture as sources of prestige are mitigated. Any reform of agricultural research and extension to fit into the globalisation and the liberalisation context should serve all of the functions of agriculture, if it has to drop local communities from poverty and to ease the transition into the globalisation. Strengthen the ability of research and extension workers to take into account the multi-functionality of agriculture may be useful in the context of globalisation.

Keywords: Agricultural research and extension, Benin, Liberalisation, Multi-functional agriculture

Contact Address: Ismail Moumouni Moussa, Humboldt-University Berlin, Rural Sociology, Luisenstr. 53, 10117, Berlin, Germany, e-mail: ismailmm@gmail.com

Liberalisation Policies and the Economic Performance under Drought Conditions: the Case of Sudan

M. B. ELGALI[2], SALAH ABDELMAGID[1], SIEGFRIED BAUER[2]

[1] *University of Gezira, Arab organization for Agricultural Development, Sudan*

[2] *Justus-Liebig-Universität Giessen, Project and Regional Planning, Germany*

This paper assesses and quantify the impact of the economic liberalisation measures adopted by the Sudan in its agriculture sector, and thier performance under drought conditions and price uncertainty. Agriculture is the main sector of Sudan's economy. Sudan is among one of the least developed countries (LDCs) of the world. The country is characterised by its small-open economy, and the economic performance is pledged to the weather conditions especially rainfall. Based on these facts, Sudan plans to put a path for the sustainable development by adopting the structural adjustments programs (SAPs) to its economy. The study develops a multi-market model for Sudan. The model embodies important characteristics of agriculture in Sudan like substitution effects and the dependency of the agricultural supply on rainfall. Stochastic variables in the model are prices, supply and the rainfall. The model is extended to incorporate food security aspects, which are directly affected by the agriculture performance. The model simulations revealed that, the direct impact of the SAPs would overall lead to considerable gains in Sudan's agricultural supply and the country's food security. However, when weather conditions are not favourable; represented by low levels of rainfalls, the positive results are overturned. The study concludes that, Sudan should adjust its domestic policy towards free market policy in order to eliminate economic distortions and benefit from the efficient use of resources. To avoid food shortages and food price fluctuations the country should keep strategic stock of cereals (Sorghum, millet, wheat and rice) amount to one third of its current consumption.

Keywords: Multi-market , Structural Adjustments, sudan

Contact Address: M. B. Elgali, Giessen University, Regional Planing, Senckenbergstraße 3, 35390 Gießen, Germany, e-mail: melgali@yahoo.com

Democracy and Decentralisation in Cambodia - Capacity Buildings for Female Commune Councilors with the Goal to Increase the Development of their Communes

MARAILE GÖRGEN
Georg August Universität Göttingen, Germany

With the introduction of the Millennium Development Goals, world wide poverty reduction obtained a new importance. To eradicate or at least decrease poverty and hunger until the year 2010, many economical as well as political terms need to be ensured. The most important issue is the guaranty of an efficient, democratic political system. With the introduction of the decentralisation reform by the Royal Government of Cambodia in the year 2001, democracy became an important aspect in Cambodian politics. Decentralisation means that certain rights, responsibilities and resources are transferred from the central level of government to the democratically elected communes. It aims to promote democracy and to improve the living conditions of the populations. In this decentralisation process, the enactment of the Law on Elections of Commune Councils took place. In February 2002 the first commune council elections were held in all 1621 communes with 11261 councilors elected. Although the 1993 constitution guarantees equality between men and women, only 8, 5 % of these elected councilors are female. That "the systematic integration of women augments the democratic basis, the efficiency and the quality of activities of local government" was recognised by the Cambodian government as well as by international stakeholders. Therefore capacity buildings were developed to strengthen the capacity of female councilors. Today, many of them are attending capacity buildings which aim to address specific challenges female councilors are facing and to enhance their capacity to perform their roles and functions. Moreover the capacity buildings provide space in order to experience sharing and networking. The capacity buildings have been successful so far: 75 % of the female councilors attending capacity buildings/forums supported by the German Technical Cooperation reported that these forums contributed to an increased knowledge about their duties and responsibilities in the council. Female councilors are able to undertake own projects that contribute to the development of their commune. Moreover 86 % of the interviewed female councilors want to restand for the 2007 commune council elections. As these results show, Cambodian women move towards a democratic, decentralised country and a society which aims to fight hunger and poverty.

Keywords: Decentralisation, Democracy, fighting Poverty and Hunger, Gender

Contact Address: Maraile Görgen, Georg August Universität Göttingen, Leinestrasse 34, 37073 Göttingen, Germany, e-mail: maraile.goergen@gmx.de

Does Food Aid Reach the Poor? New Evidence from Northern Ethiopia

SOLOMON ASFAW
University of Hannover, Development and Agricultural Economics, Germany

The paper examines the degree to which food aid (food-for-work and free food distribution) is targeted to the poorest and most vulnerable groups according to household income and asset ownership using cross section data of 149 households in Northern Ethiopia. By doing so, it is examined whether resource related indicators played an overriding role in the targeting process or whether there is a significant leakage to asset rich households. I used Heckman two-step econometric estimation procedure in an attempt to account for sample selection bias.
Food-for-work participation does not appear to be self-targeted with relatively wealthier households less likely to participate. The probability of participation was found to be mainly related to household demography like age and marital status of household head whereas resource related covariates do not appear to influence it. Households with higher farm income and oxen holding were more likely to take part in food-for-work programmes pointing to leakage in targeting. However, off-farm income is negatively related. The findings do not support the commonly held notion that female-headed households are more food insecure and should be targeted for food-for-work. The intensity of participation also doesn't seem to depend on poverty related factors, however, households with large farm size found to have spent less number of days in food-for-work programme. On the other hand the probability of participation in free food distribution programme increased significantly with increasing age and off-farm income. Households were more likely to receive free food in the current year, if they had participated in this programme during the four previous years while households that received free food only once or twice in this period were less likely to have participated in the current year.

Keywords: Ethiopia, food aid, food-for-work (FFW), free food distribution (FD), Heckman model, targeting

Contact Address: Solomon Asfaw, University of Hannover, Development and Agricultural Economics, Königsworther Platz 1, 30167 Hannover, Germany, e-mail: solomon@ifgb.uni-hannover.de

Analysis of Rice Agribusiness Development in Jember Regency, Indonesia

CIPLIS GEMA QORIAH, ADHITYA WARDHONO
Georg-August-University, Dept. of Rural Development, Germany

In Indonesia one of food plant commodities that strengthen food stability is rice. This commodity is extremely popular among Indonesian people. This relates to cultural factors and the characteristics of Indonesian societies, which continuously consume rice as food processed of rice. Rice commodities has also been dominating in Jember regency. However, the area cropped for rice in the last 4 years indicated a declining trend; it covered an area of 131.522 ha in 2003, declined from 141.880 ha in 2002. Nevertheless, rice production shows an increasing trend.

The above background initiated the author to address the following issues: **(1)** to identify socioeconomic factors dominantly affecting entrepreneurship in rice production **(2)** to find out the working mechanisms of rice distribution channel from farmers to retailers. **(3)** to find out the structure and performance market in rice commodity.

The results showed that the key factors of socio-economic aspects of rice agribusiness people in Jember are the knowledge of the commodity dealing with its process, technical ways, technology and channels of distribution, the residential area, length of time of business operation, farmers' dependence on assembling sellers and processing parties, high gaps of cost, farmers' educational level. Rice products trading in Jember is mostly dominated by farmers and, then, retailers. There are only a small number of Rice Mills and big business people; however, they have more powerful decisions on cost than those of farmers, assemblers and retailers. The structure of rice market tended to the imperfect market side. In other word we can concluded that price of rice was influenced by its supply.

Keywords: Agribusiness development, Jember regency , market rice

Contact Address: Ciplis Gema Qoriah, Georg-August-University, Dept. of Rural Development, Hermann Rein Strasse 13 / 102, 37075 Goettingen, Germany, e-mail: c_qoriah@yahoo.com

Alleviating Rural Poverty in Nigeria: A Challenge for the National Agricultural Research System

VINCENT OGUNLELA, A. O. OGUNGBILE

Ahmadu Bello University, Institute for Agricultural Research, Department of Agronomy, Nigeria

Rural poverty is a serious threat to food and nutrition security in sub-Saharan Africa and specifically in Nigeria. Land degradation, caused by human-induced soil erosion, deforestation, over-grazing and other human activities, accounts for much of rural poverty occurring in Nigeria. Apart from low external inputs, land degradation brings about low productivity in subsistence farming, while also fostering land conversion to marginal agricultural lands with fragile soils. Farm households respond to declining land productivity in diverse ways. Prospects for economic growth and future human welfare are also threatened by land degradation, whose environmental damage leads to losses in farmers' income and greater risks for poor households. An urgent reversal of this trend is necessary in order to rescue from the cycle of poverty, the rural populace, whose economic livelihood is directly dependent on land exploitation. Unfortunately, over half of Africa's rural poor are located on "low potential" and "fragile" lands. Other contributors to rural poverty in Nigeria are agricultural and economic policies of previous governments, which negatively affect farming communities. Of the many technology-related constraints of farmers, only a fraction can be addressed effectively through agricultural research. Worse still, most resource-poor farmers are unable to formally articulate their technology needs. Besides, farmers' constraints are not always researchable problems, leading to farmers' despondency, and difficulty in research priority setting. The national agricultural research system (NARS), which is expected to contribute to agricultural development and rural poverty alleviation in Nigeria, is beset by enormous constraints of low funding, poor infrastructure, and instability in staff, policy, governance and institutional arrangements, all of which are not conducive to sustained agricultural growth. The public sector research cannot do the task alone, so private sector research needs to be encouraged. Universities, with their comparative advantage, should also play active role in agricultural research activities and programmes. The various agricultural development and rural poverty alleviation programmes being embarked upon will be discussed.

Keywords: Agricultural research, environmental degradation, Nigeria, rural poverty

Contact Address: Vincent Ogunlela, Ahmadu Bello University, Institute for Agricultural Research, Department of Agronomy, PMB 1044, 810001 Zaria, Nigeria, e-mail: vbogunlela@yahoo.com

Impact Assessment of Future Development Strategies to Improve Natural Resources Conservation and Living Standards of Farmers in Lake Nasser Region, Egypt

MOHAMED AHMAD AWAD[1], WERNER DOPPLER[1], RALF SCHLAUDERER[2]

[1]*University of Hohenheim, Farming and Rural Systems in the Tropics and Subtropics, Germany*

[2]*University of Applied Sciences Weihenstephan, Department of Agriculture, Germany*

The continuous population increase in Egypt places immense pressure on the limited arable land and water resources. The establishment of new settlements was accepted as the best alternative to extend agricultural land and provide new development opportunities. Lake Nasser region is a potential area for these settlements. To ensure the establishment of sustainable farming community, three strategies were proposed: **(i)** improvement of irrigation infrastructure; **(ii)** introduction of low input crops; and **(iii)** promotion of organic farming. They were suggested based on socio-economic and environmental evaluation of the development activities in the study area to improve the living standard of settling families while alleviating any negative impacts on the environment and natural resources. Linear programming was used to simulate and analyse the future impacts of the suggested strategies on the living standards and resource use of the farming families. The model results showed that the improved irrigation infrastructure could significantly reduce: irrigation costs, hired labour and yield reduction. Accordingly, it could significantly increase the farm income and the family income. It was found that farmers could significantly benefit from their investment in the operational costs of the improved irrigation network as long as it is less than 450 $^{euro}/_{ha}$ of irrigated land. The reduced costs and the high market prices of the low input crops made the cultivation of these crops as the optimum solution for all farmers. It will result in substantial improvement of family income and hence the living standard. This strategy could significantly reduce the negative ecological impacts of using fertilisers and pesticides on Lake Nasser. The organic farming is expected to be successfully adopted in the area because the model replaced all conventional farming practices by organic farming of all crops. Organic farming could also provide higher family income even if farmers were subjected up to 60 % decrease in their yields. The successful adoption of the last two strategies requires training courses and other awareness programmes to help the farmers understanding the methods of cultivation and the usefulness of such farming practice.

Keywords: Income improvement, linear programming, natural resources conservation

Contact Address: Werner Doppler, University of Hohenheim, Farming and Rural Systems in the Tropics and Subtropics, Fruwirthstraße 12, 70593 Stuttgart, Germany, e-mail: doppler@uni-hohenheim.de

Knowledge and Education

Poverty Alleviation in Developing Countries: Principles for Agricultural Knowledge and Information System

EZATOLLAH KARAMI
Shiraz University, Agricultural Extension, Iran

Developing countries are facing two dilemma, poverty (especially rural poverty) and un-sustainability of their agricultural production systems. Current research and observations indicate that rural poverty and un-sustainability are linked. The only feasible way out of current crisis is establishment of more appropriate Agricultural Knowledge and Information Systems (AKIS).The AKIS is understood as a system that links rural people and institutions to promote mutual learning and generate, share and utilise agriculture-related technology, knowledge and information. The system integrates farmers, agricultural educators, researchers and extensionists to harness knowledge and information from various sources for better farming and improved livelihoods.
The linkage among environment, poverty and AKIS are complex and in many cases, poorly understood. The conventional AKIS of Third World countries have been criticised for their inability to alleviate poverty and contribute to sustainable agricultural development. Therefore, there is a need for innovative AKIS(s). The process of developing international guidelines and principles has been difficult. In a truly international context, there are many issues to consider and little can be taken for granted. The regulatory context varies, the cultural/religious context varies, and social and economic priorities for development vary. Despite all these limitations this paper based on the research conducted in developing countries particularly in Iran attempts to provide some principles which are essentials in establishing AKIS(s).
Such an innovative AKIS should be fundamentally different from traditional knowledge systems that support conventional agriculture. The AKIS should evolve along with changes in values and policies. It includes new actors and different roles and tasks than traditional agricultural knowledge system. Farmers deserve a more prominent placement than traditional end of the pipe user of knowledge. Other stakeholders including consumers, interest groups and government should also be considered. It requires new technologies, production systems and farming practices, which tend to be more knowledge intensive. Scientists should play a different role than their traditional producers of innovations.

Keywords: Agricultural research, poverty, Sustainability

Contact Address: Ezatollah Karami, Shiraz University, Agricultural Extension, Shiraz, Iran, e-mail: ekarami@shirazu.ac.ir

The ICARDA Approach for Knowledge Management and Dissemination (KMD): Generation and Use of International Public Goods (IPGs) for Rural Poverty Reduction

AHMED E. SIDAHMED
ICARDA, Knowledge Management and Dissmination, Syria

KMD Program aims to ensure efficient packaging and access of research generated knowledge to rural communities beyond pilot sites, thus contributing to the MDGs' rural poverty reduction targets. KMD addresses causes of poor access of pro-poor Key Agricultural Knowledge Elements (KAKEs). The aim is to capitalize on the experience gained, to affect culture and behaviour of partners ensuring equity, transparency and flexibility to achieve maximum impacts. KMD research explores innovative approaches for knowledge management; adding value to the work of ICARDA and NARS scientists; assists in taking full advantage of advances in ICTs, and building partnerships (e.g. Networks, CoPs) in generating and using KAKEs. KMD research is designed to generate Public Goods (NPGs, IPGs) from investigating approaches and processes for the dissemination, upscaling and outscaling of supply / demand based KAKEs. Supply-driven approaches justify the benefits of public investment in agricultural research and development to the concerned donor community in the short-term. Demand-driven approaches explore ways for utilising knowledge (human experience) in the development and dissemination of new technologies and embodied knowledge of social benefits. Both approaches identify methodologies; win-win scenarios; and innovations that enhance and sustain the livelihoods of a broad range of users. Therefore, KMD is undertaking research, rooted in the principles of co-learning and sharing, with the broader stakeholder community, on assessing their receptiveness to the KAKEs which can then be upscaled /out-scaled and the conditions required for their mainstreaming established. The KMD research approach has three steps: 1) Consistent analysis and documentation of existing knowledge pathways; 2. Ground truthing surveys with the broader stakeholder community for selecting valid NPGs and IPGs; 3.Dissemination: a) Up-scaling: expansion of a small-scale activity by creating demand to identify factors and favourable environments for mainstreaming, b) Out-scaling: depends on broad stakeholder support for selected KAKEs and provides a larger supply of innovations at various levels, c) Mainstreaming: developing low risk, cost effective approaches allowing equitable and wider use of KAKEs.

Keywords: Best Bet Practices, KAKE, Knowledge Management

Contact Address: Ahmed E. Sidahmed, ICARDA, Knowledge Management and Dissmination, P.O. Box 5466, Aleppo, Syria, e-mail: a.sidahmed@cgiar.org

Towards Young Professionals' Platform for Agricultural Research for Development (YPARD)

BALASUBRAMANIAN RAMANI
University of Hannover, Institute for Botany, Germany

Following the EFARD conference in Zürich (Switzerland), on April 2005 and with the support of the International Fund for Agricultural Development (IFAD), the International Plant Genetic Resources Institute (IPGRI), the Global Forum on Agricultural Research (GFAR), the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), the Consultative Group on International Agricultural Research (CGIAR), the University of Hannover, and the Swedish University of Agricultural Sciences (SLU), a group of young professionals in Agricultural Research for Development (ARD) started a dialogue with numerous stakeholders, including the Swiss Agency for Development and Cooperation (SDC), on the present scenario of young professionals in ARD. This suggestion was widely supported and found critically relevant for addressing current ARD challenges in a globalized world. A common agreement was thus reached, which recognizes that young professionals' needs, beliefs, and special competences merit a better representation in future ARD. The need for such a Platform was thoroughly discussed by a wider public of young ARD professionals at the Annual General Meeting of the CGIAR in Morocco, in December 2005. Following this meeting, it was concluded that a global platform, under the wings of GFAR, would be an important first step towards addressing the issues and concerns of young professionals in ARD. A strategic workshop of the Platform core group members was conveyed at the Wageningen University and Research Centre (The Netherlands) on 02–05 May 2006, where the vision, mission and activities of the Platform were decided. The Young Professionals Platform for Agricultural Research for Development (YPARD) was born and its official launch will take place on 8th November 2006, as a side event to the GFAR triennial conference (Nov. 9–11, 2006) in New Delhi, India. The main objectives of YPARD at present are: (1) To facilitate the exchange of information and knowledge among young professionals across disciplines, professions, age and regions, (2) to broaden opportunities for young professionals to contribute to strategic ARD policy debates , (3) to promote agriculture among young people , and (4) to facilitate access to resources and capacity building opportunities.

Keywords: Agricultural Research for Development (ARD, Challenges, GFAR, Multistakeholder platform, Opportunities, Young Professionals, YPARD

Contact Address: Balasubramanian Ramani, University of Hannover, Institute for Botany, Herrenhaueserstrasse 2, 30419 Hannover, Germany, e-mail: balasub@botanik.uni-hannover.de

Enhancing Agricultural Productivity in Sub-saharan Africa through IAR4D and Competitive Grants Processes: Experiences and Lessons

CLESENSIO TIZIKARA[1], FREDDIE KWESIGA[2]

[1]*Association for Strengthening Agricultural Research in Eastern and Central Africa, (ASARECA), Uganda*

[2]*Forum for Agricultural Research in Africa (FARA), Sub-Saharan Africa Challenge Programme, Ghana*

Revitalizing agricultural research in Africa will require addressing issues like demand-led approaches, accountability, and building of critical mass, avoidance of duplication, sustainable financing and capacity strengthening. The emergence of Integrated Agricultural Research for Development (IAR4D) as a basis for conducting research has presented an opportunity to address sub-Saharan Africa's persistent problems in new ways. IAR4D involves an innovative set of principles, an integrated research agenda, and a recognised need for greater organisational capacities and flexibility among research partners. Research is not merely intended to develop and escort new technologies to farmers but also empower farmers to better understand and respond to changing circumstances as they emerge. Competitive funding has been widely adopted as one mechanism of encouraging institutional innovation and change necessary for implementing research using the IAR4D paradigm. Research funding is moving away from open-ended institutional support towards a performance-based system where the research aims, and plans for research implementation, are developed and decided in the context of agreed priorities and value-based criteria. This situation has warranted assertive action for promoting complementary mechanisms of financing agricultural research that attracts financial resources through evidence of capability to deliver against set targets to a standard that meets the expectations of all stakeholders. Agricultural research systems must communicate better with other parties in the agricultural sector, critically question their own goals and strategies and develop the capability to showcase the contribution they make to rural development more evidently. The emerging evidence is that with careful planning and conscious commitment, competitive funding can be meaningfully harnessed to change the manner in which agricultural research is conducted and lead the transformation process necessary to turn Africa around.

Keywords: ASARECA, Competitive Grants, FARA, IAR4D, SROs, sub-Saharan Africa

Contact Address: Clesensio Tizikara, Association for Strengthening Agricultural Research in Eastern and Central Africa, (ASARECA), P.o. Box 765 Plot 5 Mpigi Road, Entebbe, Uganda, e-mail: c.tizikara@asareca.org

Taking a Systems Approach to Agricultural Education, Research and Extension: Analysis of the extension role and Practical Attachment Program of Mekelle University, Ethiopia

MAMUSHA LEMMA, VOLKER HOFFMANN
University of Hohenheim, Agricultural Communication and Extension, Germany

The capacity to benefit from knowledge depends on the ability to acquire and apply existing knowledge, and the ability to produce new knowledge. Agricultural education is central to the building of this capacity for the production, dissemination, and utilisation of knowledge. In Ethiopia, higher education is undergoing a major expansion and re-form in light of its contribution to capacity building and development. The paper discusses the development role of higher education in Ethiopia with reference to Mekelle University using a systems approach to agricultural knowledge as an analytical concept. The main focus of the paper is the Practical Attachment Program (PAP) that links education, research and extension within the university as well as between the university and its stakeholders. The PAP provides social continuity for the university, putting it in touch with rural communities and stakeholders. The development effect of the university can be enhanced when its education, re-search and extension functions are integrated and developing organically. However, extension is not a well articulated function of the university. While significant attention has been given to research, provisions for fully integrating extension within the research process have been inadequate. This paper examines efforts at Mekelle University in putting knowledge into use, and identifies critical gaps in knowledge transformation and dissemination and managing its knowledge resources. The paper finally offers conclusions and recommendations to strengthen the extension role of the university. The paper observes that improving the knowledge environment within the university requires the adoption of an effective academic reward structure of research and extension, and developing staff research-orientation and knowledge sharing culture.

Keywords: Teaching, research extension, practical attachment program, Tigray, Ethiopia

Contact Address: Mamusha Lemma, University of Hohenheim, Agricultural Communication and Extension, Stuttgart, Germany, e-mail: mamushaet@yahoo.com

Evaluation and Perspectives of Agricultural Education in Bié Province, Angola

PETRA HOLIKOVA

Czech University of Agriculture in Prague, Institute of Tropics and Subtropics, Czech Republic

The presentation is based on personal experience with one year teaching at the secondary Agricultural school provided within the project "Establishment of the Centre of Agricultural Education in Bié Province, Angola". The project has been realised by the Institute of Tropics and Subtropics (Czech University of Agriculture in Prague) and supported by the Ministry of Education, Youth and Sports of the Czech Republic as a bilateral development project from 2003 to 2005.

The 27 years civil war in Angola caused massive destruction of the country's infrastructure, disruption of markets, interruptions in the transfer of knowledge, social and economic instability. Several generations have grown up with only a minimum approach to education which is fundamental for the eradication of poverty and plays a crucial role in economic, social and cultural development. Although a former Portuguese colony has a huge agricultural potential, agricultural production is low. The establishment of quality agricultural education system is essential for a reconstruction of the sector of agriculture. The Bié Province situated on the central plateau in the middle of Angola is one of the most affected areas by the civil war.

The poster includes main problems identified in agricultural education and recommendations of its improvement. Knowledge of the majority of the students coming from basic schools is very low. Basic and secondary schools, particularly rural schools, do not function properly in the province due to lack of qualified local teachers. The quality of teaching is also impacted by the high number of students in classroom; the average number of students in class is around 50. Rate between boys and girls in classroom is unfavourable to girls; the same gender inequality is also evident between teaching staff. Although there is demand for education students have not adequate access to information sources. The local library has been destroyed during the civil war and access to Internet is scarce and expensive. The learning materials are usually incomplete; laboratories for practical training are poorly technically equipped or are missing.

Keywords: Agriculture, Angola, Bié Province, curriculum development, education and training

Contact Address: Petra Holikova, Czech University of Agriculture in Prague, Institute of Tropics and Subtropics, Kamycka 129, 165 21 Prague 6, Czech Republic, e-mail: secretary@natura.czu.cz

Impact Assessment of Farmer Field School on Cotton Production in Asia: a Cross Country Comparison

PIYATAT PANANURAK[1], SUWANNA PRANEETVATAKUL[2], HERMANN WAIBEL[1]

[1]*Leibniz Universität Hannover, Development and Agricultural Economics, Faculty of Economics and Mangement, Germany*

[2]*Kasetsart University, Department of Agricultural and Resource Economics, Faculty of Economics, Thailand*

From 2000 to 2004, Food and Agricultural Organisation of United Nations (FAO) was supporting the Farmer Field School (FFS) project on the Integrated Pest Management (IPM) training farmers under "FAO-EU IPM Programme for Cotton in Asia". The major purpose of the programme is detoxifying, existing pest control strategies, and replacing them with more sustainable, environmentally friendly cotton production technologies. In addition, the programme also develops, implements, and evaluates sustainable farmer education program. The impact of FFS on cotton production was assessed by many studies on individual country level. Results varied considerably according to the setting, the evaluation methods and the yardstick used to assess impact. In addition, whether the investment in the programme is worth to the society is an interesting question. Hence, in this study will be an alternative choice to confirm the impact results. The objective of this study is to assess and compare the impact of FFS on productivity and efficiency of cotton production in three major cotton producing countries in Asia, namely are India, Pakistan, and China. Farm level panel data were collected during the year 2000 to 2003, organised and supported by "FAO-EU IPM Programme for Cotton in Asia". Baseline surveys were conducted before the start of training (India and China is year 2000, and Pakistan is year 2001) and repeated in the year after the FFS participated. A methodology applying the "difference in difference" concept will be used in this study to evaluate the impact of FFS using impact parameters like pesticide cost, yield, gross margin, and net farm benefit. The model will be measured in each group of FFS pre and post-training.

Keywords: Cotton, different in different model, impact assessment, IPM

Contact Address: Hermann Waibel, Leibniz-University Hannover, Development and Agricultural Economics, Faculty of Economics and Management, Königsworther Platz 1, 30167 Hannover, Germany, e-mail: waibel@ifgb.uni-hannover.de

Institutions and Systems

Institutions and Social Capital

Individual Social Capital — A Structural Approach

TINA BEUCHELT[1], THOMAS DUFHUES[1], ISABEL FISCHER[1], GERTRUD BUCHENRIEDER[2]

[1]*University of Hohenheim, Rural Development Theory and Policy, Germany*

[2]*Leibniz-Institute of Agricultural Development in Central and Eastern Europe, Agricultural Development Theory and Policy, Germany*

Social capital has been recently held up as a conceptual framework to build a bridge between the diverse disciplines involved in rural development. Some researchers state that social capital can even become a joint concept for all social sciences. However, despite its potential and the impressively rapid take-up of the concept by the community of development professionals, it remains an elusive construct. No definition is yet generally accepted and many definitions are in use. Recently, social capital in the form of social networks has gained much attention in rural development theory and empirical research. Social networks or structural components of social capital are a largely missing dimension of income and poverty analysis. Moreover, most research on social capital assumes that it is a uniform entity. Therefore, the effects of different forms of social capital on household outcome are rarely investigated. Similar to the broad range of definitions for social capital, there are as many different ways to measure it. The objective of this contribution is to bring more structure into the conceptual framework of social capital and to broaden our understanding of individual social capital in rural household economies prone to poverty. After an extensive literature review, this work proposes a lean and clear definition of social capital: Social capital is best conceived as networks plus resources, (e.g. credit, information). As social capital is rooted in social networks, it should be measured relatively to its roots. Moreover, social capital is assumed to be not a homogeneous entity. Hence, it is necessary to distinguish different forms of social capital. In the case of rural areas in developing countries, the separation into so-called bonding and bridging capital seems to be most appealing. Finally, we propose the operationalization of these two forms of social capital as function of an agent's so-called weak ties (e.g. acquaintances) (plus resources) and strong ties (e.g. close relatives) (plus resources). These issues will be systematically discussed and presented in this contribution in order to make the formerly 'fuzzy' concept of social capital more tangible for empirical research in the area of rural development.

Keywords: Binding social capital, bridging social capital, definition of social capital, measuring social capital, social capital

Contact Address: Tina Beuchelt, University of Hohenheim, Rural Development Theory and Policy, Institute 490a, 70593 Stuttgart, Germany, e-mail: beuchelt@uni-hohenheim.de

Integrating Subjectivity, Self-reflection and Dialogue in Agricultural Research and Development Projects

ELISABETH GOTSCHI[1], ANDREAS HUNGER[2], BERNHARD FREYER[1], ROBERT DELVE[3]

[1]*University of Natural Resources and Applied Life Sciences, Institute of Organic Farming, Austria*

[2]*Johannes Kepler University Linz,*

[3]*International Centre for Tropical Agriculture (CIAT), Zimbabwe*

Globalisation and neo-liberal policies have an impact on development cooperation, as well as, „research for development" initiatives. More and more small projects are being replaced by programmes and budgetary support mechanisms, to address concerns over the limited focus and impact of individual projects. Though budgetary support is meant in theory to empower governments to take their own decisions and allow control over the development process, the implementation, however, has proven difficult. This paper reflects on problems in the organisation and implementation of agricultural and rural development projects. The „field theory" of Bourdieu (1979, 1993) is used to analyse challenges and problems of so-called participatory approaches. This paper argues that transdisciplinary research can contribute to the improvement of "research for development", agricultural and rural development projects in the South and the North as the global challenges do not stop in the so-called Third World but also need to be faced in the industrialised countries. Industrialized country vs. developing country; NGOs vs. beneficiaries, political vs. economic elites vs. farmers, workers in the formal and informal sector, are areas competing over these project resources. These "fields" try to distinguish themselves from others, so as to establish criteria (norms, values) that justify exclusion. Development cooperation, as well as, research for development, are fields themselves that need to consider these tendencies in their own work. The challenges are to be self-reflective and more critical towards their own field and its limitations, trying to be more open and collaborative with other partners to ensure targeting of the economically poor, the "beneficiaries" more effectively. For rural or agricultural development, or research projects, it is not sufficient to engage in "participatory" processes at regional or national headquarters, but requires working directly with farmers, men, women and children at the grassroots level. Acknowledgement of different preferences within the household and community, market instabilities and food security issues urge to focus on subsistence needs and consider socio-cultural qualities.

Keywords: Development, dialogue, participation, transdisciplinary research

Contact Address: Elisabeth Gotschi, University of Natural Resources and Applied Life Sciences, Institute of Organic Farming, Gregor Mendel Strasse 33, Wien, Austria, e-mail: elisabeth.gotschi@gmx.at

Micro-financing Institutions in Less Developed Countries: Conditions When Appropriate Changes from Informal to Formal Institutions

KAREL SRNEC, VLADIMIR KREPL, VLADIMIR VERNER
Czech University of Agriculture Prague, Engineering, Economics and Rural Development in the Tropics and Subtropics, Czech Republic

The year 2005 was declared by the UN General Assembly as the international year of micro-credit. This fact emphasises the significance of micro-finance in the collective effort of the world community to reach the Millennium Development Goals accepted by the United Nations. Micro-finance activities constantly help to reduce poverty and increase the income of the population. Micro-finances are one of the important factors influencing the reduction of public debt of Less Developed Countries. The study characterises the evolution of indebtedness from the macroeconomic viewpoint and micro-finance activities. One of the main questions is when and under which conditions it is acceptable to accelerate the transformation of informal micro-financial institutions into formal institutions. In conclusion the fundamental prerequisites and general conditions for this transformation are defined. The moment for the transformation of informal micro-financial institutions into formal institutions comes when institutions meet three requirements, so-called triangles: (1) Maintenance of the environmental stability in which they operate (critical triangle) - sustainable environment - necessity to prevent hunger - need to reduce hunger in region . (2) External sustainable development of financial institutions — external stability of institutions- financial stability, which secures the sustainable development of institutions - must have sufficient size and quality (stand up to the competition, to broaden provided services and improve their quality) - must have an effective impact on increasing economic stability and prosperity of clients . (3) Internal economic sustainable development of financial institutions — internal stability of institutions (international triangle of economic stability) - profitability — management, where returns exceed costs and micro-financial institutions (MFIs) achieve profit - liquidity — an ability to pay clients on request of their deposits (MFIs do not deal with their own financial resources and together generate cashless financial transactions)- solvency — an ability to pay from one's own ordinary income (or by conversion of property) ordinary costs and obligations in case of losses.

Keywords: Hunger reduction, indebtness, less developed countries, micro-financing, micro-financing institutions

Contact Address: Karel Srnec, Czech University of Agriculture Prague, Engineering, Economics and Rural Development in the Tropics and Subtropics, Kamýcká 129, 16521 Prague 6 - Suchdol, Prague, Czech Republic, e-mail: srnec@itsz.czu.cz

Determinants and Consequencies of Transaction Costs of Microfinance and their Impact on Rural Poor Borrowers' Incomes

JOY MUENI KIIRU[1], JOHN MBURU[2]

[1]*University of Bonn, Center for Development Research, Germany*

[2]*University of Bonn, Centre for Development Research (ZEF), Germany*

Many studies have approached the issue of transactions costs of microfinance from the institutional perspective with a view to drive recommendations on viable microfinance lending institutions. Only few studies have approached the same issue from the poor borrowers' perspective.

The major objective of the paper is to fill in this gap by attempting a rigorous analysis of the determinants of transaction costs and their impact on borrowers' small business returns or income generation. The main hypothesis of the paper is that transactions costs especially those arising from joint liability affect small businesses' profitability substantially and therefore play an important role in poverty reduction initiatives. Empirical data used for the study was generated from a random sample of about 200 rural households in Makueni District Kenya.

By use of statistical and qualitative methods the paper illustrates how group lending programmes involve individual borrowers in both joint and individual costs that result in lost incomes / business profits. It also examines how social capital, human capital, type of business, socio-economic attributes among other important factors affect the transaction costs and operations for individual borrowers in joint liability borrowing arrangements. Preliminary results indicate that the group borrowing approach weakens the social capital within the community while at the same time it increases the transactions costs of the whole group in case of loan default by a member (s).

The paper concludes by discussing the role of transaction costs in establishing efficient and viable small business ventures among the rural poor with support from microfinance. It is emphasised that in order for microfinance to serve as a poverty reduction tool, it is important to minimise the transactions costs on the borrowers' side.

Keywords: Joint liability, microfinance, rural poor, transaction costs

Contact Address: John Mburu, University of Bonn, Centre for Development Research (ZEF), Walter-Flex-Str. 3, 53113 Bonn, Germany, e-mail: jmburu@uni-bonn.de

Determinants of Intra-group Insurance in Microfinance: Evidence from Joint Liability Lending Programs in Malawi

FRANKLIN SIMTOWE[1], MANFRED ZELLER[2], JOHN MBURU[1]

[1] *University of Bonn, Center for Developemnt Research (ZEF), Germany*

[2] *University of Hohenheim, Institute of Agricultural Economics and Social Sciences in the Tropics and Subtropics, Germany*

The success of group lending with joint liability has been partly attributed to its ability to induce group members to provide mutual insurance when a member fails to repay. Although theorists have proposed conditions under which group lending with joint liability encourages group members to provide mutual insurance once some group members fail to repay their loan, very little empirical research has been conducted to test the validity of such theories. The objective of this study was, therefore, to examine the extent to which intra-group insurance occurs and to investigate the underlying determinants of the willingness of group members to offer mutual insurance. The data used in the study was collected in Malawi by the International Food Policy Research Institute (IFPRI) in collaboration with the Rural Development Department (RDD) of Bunda College of Agriculture. The data is from 99 farm and non-farm credit groups of the Malawi Rural Finance Company (MRFC). The determinants of intra-group insurance were investigated using a Probit model. The results revealed that although 89 percent of the borrowers accepted the fact that they were to contribute to repay loans for defaulting group members, only 42 percent expressed willingness to offer that support. An analysis on factors influencing the willingness of members to provide mutual insurance revealed that factors of production as well as pre-existing social ties increased the likelihood that group members would be willing to support each other. The results further indicated that the likelihood of providing mutual insurance among group members varies with dynamic incentives and risk pooling factors while peer monitoring is statistically insignificant. The presence of new members in the group, which potentially introduces a matching problem, works against mutual insurance. The cost of insurance, captured by the variation in loan size among group members, reduces the willingness of peers to contribute to repay defaulted loans of their peers.

Keywords: Dynamic incentives, intra-group insurance, joint liability, Malawi

Contact Address: Franklin Simtowe, University of Bonn, Center for Developemnt Research (ZEF), Walter Flex Str.3, Bonn, Germany, e-mail: fsimtowe@yahoo.com

Funding Agricultural Research for Connecting Local Communities to the Globalized World: Experiences from Benin

ISMAIL MOUMOUNI MOUSSA[1], BERNARD P. AGBO[2]

[1]*Humboldt-University Berlin, Rural Sociology, Germany*

[2]*Projet AGRAN (GTZ), CENAP à Agonkanmey, Benin*

Poverty alleviation and the reduction of the gap between rich and poor countries in the context of globalisation remain one of the important challenges for African research. Especially, agricultural research has a major role to play because of the socio-economical importance of agriculture in many developing countries. It became vital to establish institutional arrangements and to set up operational approaches and strategies that would help taking advantages from this major reality. This paper describes and analyses the funding strategies of agricultural research for easing the transition of local communities to the globalisation on the national scale in Benin. For this purpose, semi-structured interviews were carried out with leaders of the public research organisation, development projects, farmer organisations and NGOs. The key requirements for connecting local communities to a globalised world are **(i)** the development of commodity networks at different levels, **(ii)** the improvement of innovations for agricultural production and processing and **(iii)** the access to the international market. The strategies developed for this purpose are **(1)** the organisation of research around the main commodity, **(2)** the involvement of local communities in identifying research priorities, **(3)** the establishment of competitive grants system for improving the effectiveness and the efficiency of agricultural research and **(4)** the involvement of other stakeholders in agricultural research. The main issues to address for improving the effectiveness of agricultural research in connecting local communities to a globalised world are the investment in strategic research to build or improve the chains of values, the sustainability of the funding system and the assessment criteria.

Keywords: Agricultural research, Benin, Globalisation, Local community

Contact Address: Ismail Moumouni Moussa, Humboldt-University Berlin, Rural Sociology, Luisenstr. 53, 10117, Berlin, Germany, e-mail: ismailmm@gmail.com

Incentive Contracts Linked with Market Mechanisms: Can We Address the Water Allocation Problems in a More Effective Way?

T. S. Amjath Babu[1], Ernst-August Nuppenau[2]

[1] *Justus Liebig University, Institute of Agricultural Policy and Market Research, Germany*

[2] *Justus-Liebig-University Giessen, Institute of Agricultural Policy and Market Research, Germany*

Even though price driven mechanisms like water markets, at least theoretically, induce efficient allocation of the water resource, they often fail to achieve the goal especially in low income countries where the transaction costs are prohibitively high (especially due to extensive fragmentation of lands and peculiarities of cropping systems) and the returns from agricultural enterprises are meagre. The low price elasticity of water use coupled with political infeasibility of higher water prices are frequently driving these markets to malfunction though many international agencies advocate the formation of water users association and economic pricing of water. We believe that these failures stem from the frequent assumptions of zero transaction costs and no political infeasibility. We see a serious need of designing mechanisms that aim to fill this void. The current paper intends to propose an incentive framework that induces farmers to save water and ensures them the benefits of water trading especially in a transboundary river basin setting.

The proposed mechanism visualises a principal, who is having authority to make legally valid contracts with farmers (agents) and who prescribes a set of technical and management measures to reduce water use, who charges a penalty for the farmer, failing to adopt a subset of measures for meeting a minimum reduction, and who shares the income from the trade of saved water. This principal can be a Water Users Association holding a water use right by a grandfathering system or an authority. Any reduction from the entitled level is assumed to be transferred to the upper layer water authority that act as an agency to reallocate the saved water to those economic activities where the marginal value of water is higher, like for instance industries. The key task of this paper is to craft a principal-agent model addressing moral hazard (as efficiency of farmers in employing the technical and management measures is hidden) and to optimise the contract. The main benefits of the system can be lower transaction costs, better income for the farmers, higher political feasibility and more efficient water allocation.

Keywords: Incentives, moral hazard, principal-agent, transbounday issues, water allocation

Contact Address: T. S. Amjath Babu, Justus Liebig University, Institute of Agricultural Policy and Market Research, Senckenbergstr. 3, 35390 Giessen, Germany, e-mail: amjathbabu@gmail.com

Assistance in Establishment of Sustainable Aquaculture in Bié Province, Angola

LUKAS KALOUS[1], PETRA HOLIKOVA[2], MARTIN LOSTAK[2], JANA MAZANCOVA[3]

[1]*Czech University of Agriculture in Prague, Department of Zoology and Fisheries, Czech Republic*

[2]*Czech University of Agriculture in Prague, Institute of Tropics and Subtropics, Czech Republic*

[3]*Czech University of Agriculture, Department of Engineering, Economy and Rural Development, Czech Republic*

In the Bié province were identified possibilities of fish production as a favourable source of animal proteins for human consumption. The province was hardly affected during 27 years civil war. Infrastructure like roads, electricity, education and health systems felt to ruins. Reconstruction activities nowadays interfere with constrains caused by land mines. Factors like difficult transport of goods and food from the coastal harbours, restricted area for local food production and long-term interruption of agricultural production, which resulted in inexperienced farmers, lead to food deficiency.

Although fish are important part of human nutrition in the province, fish production from rivers is insufficient at present. The natural stocks are in many places grossly overfished mainly by usage of fish poison (leafs of *Tephrosia spp.*) and explosives. This unselective catching approach has resulted in a serious decline of fish availability in some areas. On the other hand almost all communities have small streams close to the village which also could be potential sites for fish farming. Very good climatic conditions and natural water resources challenge the feasibility of sufficient fish production.

The advantage of fish farming is relatively cheap and easy to establish its production. Introduction of aquaculture ponds into farming systems can improve the economic and ecological sustainability of resource-poor farms. Potential benefits from integrating aquaculture in smallholder farming systems include: producing high nutritional value food for human consumption, contribution to rural income via employment within farming as well as within related activities and improvement of food security due to diversification of the production. The fisheries sector, including fish farming, is one of the priority sectors targeted for development for the province government.

Main tasks for establishment of fish production in the Bié province represent:

Identifying fish species that can be reared in fish ponds or cages (preferably local species to reduce negative impact to native fish communities).

Development of integrated extensive fish farming technology suitable for local conditions.

Assistance with construction of pioneer integrated fish farms within the local communities.

Providing workshops and information campaign on the possibilities of fish farming.

Keywords: Angola, fish farming, fish production, nutrition

Contact Address: Petra Holikova, Czech University of Agriculture in Prague, Institute of Tropics and Subtropics, Kamycka 129, 165 21 Prague 6, Czech Republic, e-mail: secretary@natura.czu.cz

Cotton Production Technologies and Women's Time Use: Giving More Attention to Children Education, Health and Nutrition

DANSINOU SILVERE TOVIGNAN[1], DAVO SIMPLICE VODOUHÈ[2]

[1] *Justus-Liebig-University Giessen, Institute of Agricultural Policy and Market Research, Germany*

[2] *University of Abomey-Calavi, Agricultural Extension, Benin*

Cotton is for most francophone West African countries the main export crop is subject of many challenges not only in terms of international trade, but also in terms household management in rural communities. Cotton producers in West African setting are small-scale farmers working mainly with family labour. Production activities require both male and female labour. Actually, two main production technologies (organic and conventional) are used with different labour demand features, particularly female labour. The development of organic cotton gives women the opportunity to hold their separate cotton farm and draw cash income from it. This study investigates how cotton production technologies adopted by the household (organic or conventional) influence the time use systems of women and the impact on children education, health and nutrition that are also household responsibilities demanding particular time investment from women. The goal of the paper is to make aware, projects, NGOs and institutions working on education, health and nutrition issues in rural area, that, their strategies should be adapted to specific time use systems of women. Therefore, it aims also to provide them with accurate data to ease strategic decision-making. Data for this paper have been collected from both conventional and organic cotton producers' household having children less than 10 years old in central Benin. Preliminary tentative results confirm the difference of time use systems of women in household adopting organic and conventional cotton. Particularly, women holding their own cotton farm share their working time between the husband's farm and their own farm. By getting their own income, they contribute financially more to the education and health of their children. However, they lack time in choosing appropriate food combination for their children. As the health situation of an individual depends first of all on his nutritional state, nutritional trainings should be targeted to those women who are getting increasing interest in holding separate cotton farm.

Keywords: Conventional cotton, education, gender, health, nutrition, organic cotton, time planning

Contact Address: Dansinou Silvere Tovignan, Justus-Liebig-University Giessen, Institute of Agricultural Policy and Market Research, Senckenberg Str. 3, 35390 Gießen, Germany, e-mail: Dansinou.S.Tovignan@agrar.uni-giessen.de

Collective Action by Women's Groups to Combat Drought and Poverty in Northern Kenya

SOLOMON DESTA[1], LAYNE COPPOCK[2], ADAN WAKO[3], IBRAHIM ADEN[3], GETACHEW GEBRU[4], SEYOUM TEZERRA[4], CHACHU TADECHA[3]

[1]*Global Livestock CRSP Pastoral Risk Management Project, c/o International Livestock Research Institute, Kenya*

[2]*Utah State University, Dept. Environment & Society, United States*

[3]*Community Initiatives Facilitation and Assistance, Kenya*

[4]*Global Livestock CRSP Pastoral Risk Management Project, c/o ILRI, Ethiopia*

Collective action can be an effective means of local development and risk reduction among rural people, but few examples have been documented in pastoral rangeland areas. We conducted extensive qualitative interviews for 16 women's groups residing in settlements in northern Kenya during early 2005. Our objectives were to understand how groups were formed and governed, what activities they have pursued, and to what extent such groups can mitigate drought crises and reduce poverty for their members. The groups we interviewed had existed for an average of 10 years. Group size averaged about 24 women, 20 of whom were typically illiterate. Half of the groups had formed after facilitation by a GO or NGO partner and half formed spontaneously. Groups are governed under detailed constitutional frameworks. Leaders are typically elected. Groups primarily form to improve living standards of the members. Groups undertake a wide variety of social and economic activities founded on savings and credit schemes, income diversification, small business development, and expansion of education, health service, and natural resource management functions. Groups have also taken an active role in mitigating drought impacts on their members. There are many examples of group members that have lifted themselves up from destitution. The greatest threats to the sustainability of these women's groups come from external factors such as drought and political incitement as well as internal factors such as unfavourable group dynamics and illiteracy. Principles of good group governance and wisdom in business creation and management were repeatedly stated by respondents as the key ingredients for long-term success. Groups have ambitious plans to further improve their social and economic circumstances; rates of group formation in the region appear to be increasing. In a highly risky and poverty-stricken environment such as northern Kenya, such groups help create relatively deep pools of social, human, and diversified economic capital. Many of these processes fill large gaps in public service delivery and should be encouraged by policy makers.

Keywords: Boran, human capital, pastoral development, Rendille, social capital

Contact Address: Layne Coppock, Utah State University, Dept. Environment & Society, 84322-5215 Logan, UT, United States, e-mail: Lcoppock@cc.usu.edu

Factors Influencing Cooperation and Collective Action: Implications for Communal Cattle Breeding Schemes in Trypanosomosis Prevalent Areas in Eastern Africa

EMILY OUMA[1], AWUDU ABDULAI[1], ADAM DRUCKER[2]
[1]*University of Kiel, Department of Food Economics and Consumption Studies, Germany*
[2]*Charles Darwin University, School for Environmental Research, Australia*

In sub-Saharan Africa, many rural populations live in absolute poverty and suffer from chronic hunger. Most of these populations comprise livestock keepers and smallholder farming communities who eke out a living under harsh environmental conditions. Animal diseases are serious constraints to livestock productivity in African rural areas and reduce opportunities for improving food security and reducing poverty. Modern biotechnology approaches provide key components of improving livestock productivity by introducing genes that control desirable traits such as disease tolerance through marker assisted breeding with great precision, resulting in improved strains of livestock. In order for rural populations to benefit from such kind of innovations, sustainable access pathways need to be identified. Communal group breeding schemes have been identified in literature as sustainable and potential pathways to achieve measurable genetic gains of desirable livestock traits from nucleus herds in subsistence systems of developing countries. However, there exists a knowledge gap on factors that may influence the likelihood of success of such communal-based schemes. Such information would be useful in developing appropriate interventions as community participation and cooperation in developing countries increasingly get centre stage in the policy arena as a pathway towards achieving sustainable economic development. This paper investigates factors that influence community participation in communal development initiatives in trypanosomosis prevalent production systems in Narok and Suba district of Kenya and the Ghibe valley in Ethiopia, which mainly comprise pastoral, agro-pastoral and mixed crop-livestock systems. In these systems, cattle keepers have preferences for traits associated with trypanotolerance, fecundity and traction potential; traits which could be integrated in breeding objectives and selection indices in breed improvement programs. Game theoretic models as well as econometric models are applied.

Keywords: Communal participation, Eastern Africa, livestock productivity, trypanotolerance

Contact Address: Emily Ouma, University of Kiel, Department of Food Economics and Consumption Studies, Olshausenstrasse 40, 24098 Kiel, Germany, e-mail: eouma@food-econ.uni-kiel.de

Social Ecology

Promotion of Traditional Animal Traction Practices among the Shangaan People of Mozambique for Poverty Alleviation

ROMUALD RUTAZIHANA, JACOB WANYAMA, EMMA BRADLEY
Vetaid Mozambique, Gaza Food Security Project, Mozambique

The Shangaan people are agro-pastoralists who live in the south of Mozambique. The Shangaan who originated from near the central Africa came into the present day Gaza Province of the Republic of Mozambique from further south as they fled the Zulu wars. Traditionally the Shangaan people till their land along the Limpopo valley, keep livestock and fish for their livelihoods. Livestock kept include cattle, sheep and goats, pigs and chicken. Like most rural poor populations in developing countries, the Shangaan community use their animals for their transport and land tilling needs. The Shangaan have therefore developed a rich knowledge on how to keep, handle and use their animals for power. Animals used for drought power include cattle and donkeys. However, over the years, the Shangaan people have encountered a series of disasters that have affected the conservation and use of their traditional knowledge. The liberation war from the Portuguese, the civil conflict which started immediately after their country got independence, floods and frequent droughts, resulted in displacement and loss of the draught animals, as well traditional knowledge. With the signing of peace accord in 1992 and the subsequent accelerated development effort in their region, the Shangaan agro-pastoralists are, not only having to rebuild their herds, but also their knowledge on how to handle and use their animals their power needs. To promote this knowledge and practice, VETAID Mozambique conducted a survey on the traditional techniques of animal traction in the north of Gaza Province. The objective was to evaluate the traditional techniques in the region and design a programme to integrate these techniques with appropriate modern techniques for the food security of these people. This paper presents the results of this survey how by use of Endogenous Livestock Development approach VETAID Mozambique and its partners is promoting the use of animal draft power in a bit to ensure food security.

Keywords: Community-based Animal Traction Centres, Endogenous Livestock Development, Food Security, the Shangaan people, Traditional Animal Traction Practices, VETAID Mozambique

Contact Address: Jacob Wanyama, Vetaid Mozambique, Gaza Food Security Project, Rua Dos Combatentes Talhao No. 13, C.P. 44, Chokwe, Mozambique, e-mail: wanyama@vetaid.net

Local and Scientific Knowledge on Natural Resource Management - A Case Study from Northwestern Namibia

JENNY EISOLD[1], SILKE TÖNSJOST[2], MICHAEL BOLLIG[1], ANJA LINSTÄDTER[1]

[1]*University of Cologne, Savanna Range Management - Ecological and Economic Sustainability, Germany*

[2]*University of Cologne, Institute of Cultural and Social Anthropology, Germany*

In todays complex web of socio-economic, political and environmental changes, natural sciences approaches might offer insufficient understanding of the dynamics underlying the socio- ecological systems. Local knowledge is an important key to understand pastoralists strategies of sustainable resource management. It is especially interesting to investigate how local knowledge is produced and used in a highly unpredictable system, characterised by non- linear dynamics. Pastoralism is the dominant form of land use and economy in the arid north western part of Namibia. Therefore the sustainable management of natural resources is important to guarantee future subsistence in this region. Local knowledge is embedded in power relations as well as in specific conditions and is one framework in decision- making processes. Pastoralists adopt and reject management options on the basis of perceived indicators in order to cope with the variability of natural resources in space and time. Anthropological and ecological data are compared and synthesized to gather new insights concerning range management and decision-making processes regarding mobility. By contrasting the data of the in- and outsiders view, the similarities and differences between the scientific knowledge and local knowledge on range management will be shown. Our comparison of local and ecological perspectives is based on the perception of OvaHerero pastoralists on a Communal Conservancy and the range ecologists´ view. It focuses on three core aspects of range management:**(i)** Indicators for range assessment, **(ii)** Important fodder plants, **(iii)** The perception of environmental change in selected grazing areas. Synergetic effects between both concepts of knowledge will help to gain a better understanding of local management strategies. Thus our interdisciplinary approach not only contributes to the interpretation and understanding of ecological processes in the highly stochastic and sensitive environment of African arid savannahs. It is also valueable for identifying crucial aspects of a successful management of natural ressoures in drylands. Thus sustainable management strategies, that meet the introductory mentioned challenges can be improved.

Keywords: Cognitive Anthropology, local Knowledge, Namibia, Natural Resource Management, Range Ecology, Savannah

Contact Address: Jenny Eisold, University of Cologne, Savanna Range Management - Ecological and Economic Sustainability, Gyrhofstraße 15, 50931 Cologne, Germany, e-mail: jenny.eisold@uni-koeln.de

The Status of Urban and Peri-urban Agriculture in Khartoum, Sudan

KAMAL EL-SIDDIG[1], JENS GEBAUER[2], HUSSEIN DAWOUD DAWOUD[3], ANDREAS BUERKERT[2]

[1]*Agricultural Research & Technology Corporation, Cotton Research Program, Sudan*

[2]*University of Kassel, Organic Plant Production and Agroecosystems Research in the Tropics and Subtropics, Germany*

[3]*Agricultural Research Corporation, Shambat Research Station, Khartoum North, Sudan*

Khartoum, the capital of Sudan, is located at the confluence of the Blue Nile and White Nile. The city has grown rapidly in recent years and today has an estimated population of six million people including two million refugees fleeing the past civil war in the southern Sudan as well as the ongoing civil war in the western Sudan. Khartoum is located in the semi-arid savannah belt of the Sudan, with an average annual rainfall of 200–300 mm and a long dry season from September to June, though there is much variation in both the amount and frequency of rainfall from one year to the next. A wide spectrum of production systems can be found ranging from household subsistence to large-scale commercial farming. Horticultural crops grown in Khartoum state comprise a long list of vegetables, fruit trees, ornamental plants, and medicinal and aromatic plants. Some of these crops are indigenous to the country while others are exotic. Some are considered of major importance in the world while others are of minor importance and local usage. In addition, intensive livestock production systems for milk, meat, and poultry or egg production are operational within and around Khartoum city. In view of the large gap in data on food and related nutrient-flows between urban and peri-urban, studies must be conducted to minimise nutrient depletion and to maximise environmentally sound land management. Therefore, a research project founded by the Alexander von Humboldt Foundation is launched with the objective of quantifying nutrient fluxes and understanding nutrient replenishment and waste recycling. The knowledge obtained from this project will help to minimise nutrient depletion and maximise environmentally sound land management and offer the opportunities for effective involvement of the urban and peri-urban sector in nutrient recycling.

Keywords: Nutrient fluxes, urban and peri-urban agriculture, vegetables, fruit production

Contact Address: Kamal El-Siddig, Agricultural Research & Technology Corporation, Cotton Research Program, P.O. Box 126 Wad Medani, Sudan, e-mail: k_elsiddig@yahoo.com

Assessing the Current Land Use Management and Crop Systems on the Sloping Land in Central Vietnam: A Representative Case Study of Thuy Bang Commune

CHUONG VAN HUYNH
Humboldt-University Berlin, Faculty of Agriculture and Horticulture, Germany

Vietnam is an agricultural country.In recent years Vietnam has made significant improvements in agricultural productivity through the intensification of lowland rice production and the increased use of improved crop systems and new land use policies. The greatest potential for expansion of cropland is in the sloping areas of central Vietnam. But much of the central Vietnam is still underdeveloped. This region is characterised by widely variable soil types, many of which are of low fertility, prone to erosion and severe climate.
Main objective is to assess the existing land use management issues and to delineate the crop systems those are influencing to agricultural production and food security. A case study of about 2298 ha of Thuy Bang commune, Thua Thien Hue province has been selected to be stimulated through the incorporating of participatory rural appraisal, secondary data, farmer seminar and SWOT analysis. The study has found that farmers in the sloping areas are focusing on the planting of annual crops such as low rice, maize, peanut and cassava, beans, vegetables, sweet potato as well as perennial crops such as fruits trees, pepper and forestry trees. Many of these crops are cash crops that were expected to improve the incomes and living standards of sloping farmers. Differentland use types identified: Winter-Spring rice + Summer-Autumn rice; Winter-Spring rice + fallow; Winter-Spring rice + beans; Winter-Spring peanut + cassava or maize; Winter-Spring sweet potato + cassava; Winter-Spring vegetables + Summer beans or peanut; Fruit trees + bean or peanut, forestry trees. The current land use management is still limited and lack of land information for local people, the land use issues for all purposes are the lack of precision planning. The major constraints are the poor cultural, educational and economics situation of the residents and the poor professional competence of the local land administration staffs. There is a need to change these tillages, crop residue management practices to reduce soil erosion rates, develop soil fertility and increase crop yield as well as better land use management policies.

Keywords: Central Vietnam, crop systems, land use management, land use types, sloping land

Contact Address: Chuong Van Huynh, Humboldt-University Berlin, Faculty of Agriculture and Horticulture, Lentzealle 75, D- 14195 Berlin, Berlin, Germany, e-mail: van.chuong.huynh@rz.hu-berlin.de

Diversification of Shifting Cultivation Cycles among Small-scale Farmers in the Peruvian Amazon

LUCIE PROCHAZKOVA, BOHDAN LOJKA, JAN BANOUT, JANA LOJKOVA, ZBYNEK POLESNY, DANIEL PREININGER

Czech University of Agriculture in Prague, Institute of Tropics and Subtropics, Czech Republic

Since the population in developing countries increases, the agriculture expand into the new area, which is mainly forest in the tropics. About 60 % of the deforestation of tropical rain forests is carried out by small-scale farmers. This research is focused on the Amazon basin, where small-scale farmers widely practice shifting cultivation. Main objective was to create a classification system of methods of land use and found out typical crop sequence, composition and length of particular phases of shifting cultivation cycle on the basis of fields' history. Land use was examined in two settlements-Antonio Raimondi and Pimental in Ucayali, Peru. Research aimed at characterising the differences in land use after initial slash-and-burn. Data were gathered through semi-structured questionnaire and were focused on socio-demographic and field characteristics, crop sequence and composition, and length of different stages of shifting cultivation cycle currently practised among agroforestry-reliant households (n= 27). Visit to crop field and forest fallow aimed to reconstruction of extensive cropping history. Several specific cycles were identified for each study site. Whereas settlers in Antonio Raimondi plant annual crops after slashing and burning the forest, settlers in Pimental gave more importance to perennial crops. Process of deforestation and land degradation is relatively more pronounced in younger settlement (Antonio Raimondi). These differences are caused by different social backgroung. Land holdings among households within traditional communities are unequally distributed and reflect local land scarsity. These results question the view of indigenous agriculture systems as 'unsustainable' and underscore the importance of studying local variation in indigenous agroforestry practices.

Keywords: Agroforestry, deforestation, land degradation, slash-and-burn, swidden-fallow

Contact Address: Lucie Prochazkova, Czech University of Agriculture in Prague, Institute of Tropics and Subtropics, Kamycka 129, 165 21 Praha 6, Czech Republic, e-mail: lucka.proch@centrum.cz

Analysis and Evaluation of the Agro-potential of Inland Valleys in the Upper Ouémé Catchment (Benin, West Africa)

SIMONE GIERTZ[1], GERO STEUP[1], CHRISTINE STADLER[2], SARAH SCHÖNBRODT[3], BERND DIEKKRÜGER[1], HEINER GOLDBACH[3]

[1]*University of Bonn, Department of Geography, Germany*

[2]*University of Bonn, Institute of Crop Science and Resource Conservation - Plant Nutrition, Germany*

[3]*University of Göttingen, Department of Landscape Ecology, Germany*

The fast growing population in all countries of sub-Saharan Africa demands an increase of food production. In some regions the arable land becomes already scarce and the degradation of soils progresses due to the shortening of the fallow period. Inland valleys offer an extensive, fairly unexploited potential for agricultural production, due to their higher water availability, lower fragility and higher fertility compared to the upland soils. In the last decade the Upper Ouémé catchment in central Benin is subject to high population growth caused by high fertility and high immigration rates. This causes an expansion of agricultural area, which leads to deforestation and shortage of available land for agricultural production. Therefore, the exploitation of inland valleys will become more important in this region. The presented study aims to analyse the present and future agro-potential of the inland valleys. To assess the surface of the inland valley area a multilevel approach is applied combining DEM-analysis, remote sensing and field mapping. Based on the field work a typology of inland valleys is carried out in order to extract representative inland valleys for each type, which are intensively investigated in terms of physical aspects. For evaluating the usability, socio-economic aspects as distance to the next market are taken into account. Based on these investigations the assessment of the present and future agro-potential is performed by an interdisciplinary modelling approach. The effects of future climatic and land use changes on the hydrology of the inland valleys are analysed using a hydrological model. As a result the temporal variability of the extent of the saturated area and the length of the period with sufficient water availability for cultivation in the inland valleys are used in the plant growth model. With this model different cultures are simulated in order to assess the potential yields. The work is carried out in close collaboration with local authorities. The results of this study will create a reliable base for the planning process of inland valley exploitation in the region.

Keywords: Agro-potential, hydrological model, inland valleys, plant growth model

Contact Address: Simone Giertz, University of Bonn, Department of Geography, Meckenheimer Allee, 53115 Bonn, Germany, e-mail: sgiertz@uni-bonn.de

The Cultivation of Vegetables in the Central Hills and Mountains of Nepal — Implications for Poverty and Food Security

GANESH RAJ JOSHI[1], LILA KARKI[2]

[1]*Department of Agriculture, Ministry of Agriculture and Cooperatives, Government of Nepal, Nepal*

[2]*Justus-Liebig-University Giessen, Institute of Agriculture and Food Systems Management, Germany*

The vegetables and potato are the important crops in terms of nutrition and income in Nepal. These crops share about 7 percent of the total gross cropped area. The area and production of these crops is increasing in the recent years especially in the mountains and hills with the development of roads and marketing infrastructures.

A study was undertaken with a view to identify the factors that determine the area allocation decision under vegetables and potato by 176 farming households in the mountains and hills of the central development region of Nepal. The study reveals that on an average, a household allocated 0.25 hectare area to these crops and also these crops contributed about 27 percent to the total cash income of the household. The area allocation decision of the household was analysed by using a two-limit tobit procedure because about 7 percent of sampled household did not allocate any area for these crops. The analysis showed that the education of the household head, nearness of the villages to the road heads and markets and the training imparted to farmers on vegetable crops have significant and positive effect on the area allocation. On the other hand, the area under the competing crops such as wheat during winter season and the maize during rainy season has negative significant effect on the vegetables' area allocation. This is because farmers' in these regions especially in the inaccessible areas still prioritise the cultivation of staple crops from the perspective of household food security. The findings of this study have important implication for reducing poverty and strengthening food security. This can be achieved through developing and improving the roads and markets, strengthening the technical capability of the farmers by education and imparting trainings and strengthening existing extension services and network.

Keywords: Cultivation, food security, Hills, Mountains , Vegetables

Contact Address: Ganesh Raj Joshi, Department of Agriculture, Ministry of Agriculture and Cooperatives, Government of Nepal, Nepal, e-mail: grjoshi20@yahoo.com

Banana Tissue Culture: Benefits for East African Farmers

BJÖRN NIERE[1], CLIFFORD S. GOLD[2], DANNY COYNE[3], THOMAS DUBOIS[3], DENNIS OCHIENO[3]

[1]*Federal Biological Research Centre for Agriculture and Forestry, Institute for Nematology and Vertebrate Research, Germany*

[2]*CIAT, Uganda*

[3]*IITA, ESARC, Uganda*

Banana is the main food staple and a key component of food security in the Great Lakes region of eastern Africa. Banana is also an important cash crop in parts of Rwanda, Tanzania and Uganda. Where it is grown, it often makes the highest contribution to household income. A complex of biotic and abiotic factors imperil banana in the region. The banana weevil and a complex of nematodes are considered the most important pests on East African highland bananas. Pest and diseases of banana are mainly transmitted with infested banana suckers, traditionally the planting material of this vegetatively propagated crop.

Propagation of pest and disease-free banana planting material and the introduction of new pest and disease-resistant banana varieties is therefore of vital importance for the well-being of farmers in the region. Pest and disease-free banana can be micro-propagated in tissue culture. Tissue cultured banana are the preferred planting material in commercial plantations all over the world. Even in the absence of pests, tissue cultured banana also have higher yields and mature earlier than sucker-derived material. Currently, tissue cultured banana planting material is not widely available to farmers in Rwanda, Tanzania, and Uganda due to insufficient dissemination channels in this region. This is attributed to a lack of understanding of the benefits of this technology. There is also a lack of agronomic data demonstrating the benefits of tissue cultured banana belonging to the unique group of East African highland banana (*Musa* AAA-EA). Data on performance of tissue culture plants for the plant and ratoon crop will be presented. Plant and ratoon crops of tissue cultured banana under different management regimes are compared to suckers derived planting material, including hot-water treated suckers. Additional benefits are expected through the absence of pest and diseases.

Keywords: Banana weevil, east African highland banana, nematode, tissue culture

Contact Address: Björn Niere, Federal Biological Research Centre for Agriculture and Forestry, Institute for Nematology and Vertebrate Research, Toppheideweg 88, 48161 Münster, Germany, e-mail: b.niere@bba.de

Research Experiences from the Field : India prosperity and Poverty in a Globalized World ? challenges for Agricultural Research.

NITYA GHOTGE, SAGARI RAMDAS

Anthra, India

During the latter half of the previous century, agricultural and livestock research in India were dominated by green revolution technologies, monocultures, the propagation of hybrids and the replacement of local knowledge and farming systems with imported technology. While these technologies did bring prosperity to some, they also enhanced the poverty of many who were unable to cope with the demands made by the exotic technology . By 1992, the negative environmental consequences of these technologies led to certain key international conventions such as the CBD Convention on Bio Diversity being signed by different nations. The importance of biodiversity began to be discussed and research itself slowly began to explore horizons beyond the green revolution. At about the same time the WTO also came into place calling for new economic polices, structural adjustment programmes and globalisation of the economy in India. By the beginning of this century, research in the country was forced to face the challenges of globalisation both in the formal and non formal sectors . Since 1996, ANTHRA (a resource organisation working on strengthening peoples livelihoods, through supporting sustainable livestock production) in response to the needs of livestock owners has been involved in action research with different communities; pastoral, peasant, tribal - to document, validate and disseminate valuable local practices and indigenous knowledge systems related to livestock breeds, livestock health, housing, management, nutrition, fodder varieties, grazing methods as well as the gender dimensions of these practices. Overwhelmingly, our findings on local practices have been that many of these work excellently, are in tune with local cultures, economies and environment and have enormous potential if applied appropriately of significantly improving the livelihoods of extremely marginal communities. While these practices may not bring great “prosperity” as in a globalised world poor farmers are seldom in a position to keep pace with international market swings, this form of endogenous livestock development would probably equip poor livestock owners to stave of the danger of crippling poverty far better than the green revolution technology could .

Keywords: Action research, Convention on Biodiversity, endogenous livestock development, green revolution, indigenous knowledge, livestock research , WTO

Contact Address: Nitya Ghotge, Anthra, F Lantana Gardens Nda Road Bavdhan, 411021 Pune, India, e-mail: anthra.pune@gmail.com

Evaluation of Vegetable Farming Systems for Competitiveness in Upland Areas of Indonesia

IDHA ARSANTI[1], MICHAEL BÖHME[1], HANS E. JAHNKE[2]

[1]*Humboldt University Berlin, Horticultural Plant Systems, Germany*

[2]*Humboldt-Universität Berlin, Development Planning and Project Management, Germany*

Vegetable farming systems (VFS) in uplands in Indonesia comprise some horticultural products, like mustard, cabbage, potato, carrot, chilli, and cauliflower. Its production is important for the vegetable consumption in Indonesia. The research is focused on the problems regarding the profitability, sustainability and competitiveness of VFS and to clarify the highest priority product to be cultivated in the upland area.

The information and data from the literature were not enough to get answers of the questions. Therefore it was necessary to collect primary data in the investigated regions. This data collection was carried out in three upland areas by analysing two villages in each with main vegetable producer in order to characterise the typical physical condition of agroecology. It is then applied a respondent classification based on commodity on these two villages in each region. In each village 25 respondents (50 respondents in the two villages) were interviewed. The number of all respondents in all regions is 150 farmers. The Domestic Resource Cost Method, Cost Benefit Analysis and Analytical Hierarchy Method were used in this study, especially for calculation of economical value.

This research shows that VFS in upland areas of Indonesia is profitable, especially for potato, cabbage and carrot, but for other vegetable products, such as chilli and mustard have no profitability. Vegetable products which have comparative and competitive advantages are cabbage and potato, and otherwise based on social and economic analysis, both of them can be sustainable. The highest priority product to be cultivated in upland area is potato, it considers not only profitability aspect but also marketing condition and sustainability perspective.

Based on the results of this research, it can be concluded that some of programs are necessary to be created for the government in order to support the development of vegetable farming system in upland areas, such as technical assistance, improving the quality and safety standards of products, developing competitive agribusiness areas, especially for potato and cabbage as export and import substitution products based on the agro ecosystem advantage or infra structural in each region.

Keywords: Social economy, sustainable agriculture, vegetable farming system

Contact Address: Idha Arsanti, Humboldt University Berlin, Horticultural Plant Systems, Lentzeallee 75, 14195 Berlin, Germany, e-mail: idha_arsanti@yahoo.com

How to Scale-up Sustainable Agricultural Practices?

WIBKE CREWETT[1], FRANZISKA BRINGE[2], STEFAN SIEBER[2]

[1]*University of Göttingen, Institute of Social- and Cultural Geography, Germany*

[2]*Leibniz-Centre for Agricultural Landscape Research (ZALF) e. V., Institute of Socio-Economics, Germany*

Recent research work approached the topic of sustainable agriculture in the developing world and indicated its contribution to reducing poverty (Pretty and Hine 2001). Examples from the field reveal that a larger number of sustainable agricultural practices which can be easily adapted to different environmental settings are at hand. These practices that often combine traditionally and scientifically generated knowledge are regarded to provide excellent opportunities to improve the livelihoods of small and poor farmers. Since such "good practices" are available their wider dissemination is considered a major tool to contribute to the alleviation of poverty. However, scaling-up of such low-cost and input-saving agricultural practices lags behind time. Until now only little systematic analysis of why scaling-up of sustainable agriculture shows only poor results as well as recommendations on what could be done to speed up the diffusion of good practices to more farmers is very general. There are some macroeconomic factors identified to be conducive to scaling-up as well as there is a theory which explains the driving forces that determine the adoption of innovations but an applicable framework for practitioners and decision-makers to assess scaling-up potentials of particular practices as well as to provide guidance for planning scaling-up activities to foster dissemination of those practices is still missing. Addressing these issues, the Leibniz-Centre for Agricultural Landscape Research (ZALF) in cooperation with GTZ-Sustainet and FAO on behalf of BMELV carried out an analysis of a number of case studies on good practices from Africa and Asia to more systematically examine determinants of scaling-up of good practices. As a result, the research team developed a generalisable framework to analytically approach scaling-up activities at the project level. Taking into account the resource requirements of the innovation, the potential of the local community as well as the qualities of the implementing organisations it enables planners to more systematically assess and design scaling-up activities.

Keywords: Good Practices, scaling-up, Sustainable Agriculture

Contact Address: Stefan Sieber, Centre of Agricultural Landscape Research E.v., Institute of Socio-economics, Eberswalder Straße 84, 15374 Müncheberg, Germany, e-mail: stefan.sieber@zalf.de

Adoption and Impact Assessment

Technology Adoption under Heterogeneity and Uncertainty: the Case of Bt-cotton Production in Karnataka, India

ASHOK MALKARNEKAR[1], DIEMUTH PEMSL[2], HERMANN WAIBEL[1]
[1]*University of Hannover, Development and Agricultural Economics, Germany*
[2]*WorldFish Center, Policy, Economics, and Social Sciences, Malaysia*

Bollworm resistant Bt cotton varieties were introduced in India in 2002 with great expectations with regard to a reduction in the use of insecticides.
A panel of 100 early adopters of Bt cotton in Karnataka State in South India was studied to investigate the adoption and productivity of the new varieties. Data used in the analysis is from farm level interviews with early adopters conducted in 2002/2003 (the first Bt cotton season) and the same group of farmers supplemented by a control group in 2004/2005. The impact of Bt varieties on insecticide use and output is assessed using production function analysis within a damage control framework. In addition, a stochastic partial budgeting model is used to assess the net benefits of different bollworm control options. The assumptions for this modelling exercise are partly derived from the descriptive findings of the case study. Furthermore, the marginal productivities from the econometric modelling have been linked to the simulation model.
Contrary to widespread perceptions, results indicate considerable pesticide overuse and good damage control effects at low levels of insecticide use and for Bt and non-Bt cotton users. Simulations to assess the comparative performance of different pest management strategies indicate that potential pest damage and potential yield are important determinants of pest control profitability. The model confirms the observed disadoption behaviour for Bt varieties among many farmers in Karnataka state. The simulation results also suggest that need based integrated pest management (IPM) strategies outperform other strategies in most of the scenarios.

Keywords: Bt-cotton, India, panel data, production function estimation, stochastic simulation

Contact Address: Ashok Malkarnekar, University of Hannover, Development and Agricultural Economics, Königsworther Platz 1, 30167 Hannover, Germany, e-mail: ashok@ifgb.uni-hannover.de

Adoption and Diffusion Processes of Silage Technology in the Area of Yoro, Honduras

CHRISTOPH REIBER[1], RAINER SCHULTZE-KRAFT[1], MICHAEL PETERS[2], VOLKER HOFFMANN[3], PETER LENTES[4], H. CRUZ[5], CARLOS LASCANO[2]

[1]*University of Hohenheim, Institute of Plant Production and Agroecology in the Tropics and Subtropics, Germany*

[2]*International Centre for Tropical Agriculture (CIAT), Colombia*

[3]*Universität Hohenheim, Department of Agricultural Communication and Extension, Germany*

[4]*International Centre for Tropical Agriculture (CIAT), Honduras*

[5]*Dirección de Ciencia y Tecnología Agropecuaria (DICTA), Honduras*

Feed shortage during the 5–6 month dry season in extended areas of Central America severely limits livestock production. An alternative feeding strategy to overcome this constraint includes silage preparation during the rainy season. However, adoption of forage conservation methods by small-scale farmers has been low. Reasons include high investments required, lack of know-how and lack of knowledge of appropriate low-cost alternatives.

In 2002, CIAT and its partners identified the need and demand for forage conservation technologies by farmers in the area of Yoro, Honduras. Silo types such as heap and earth silos and especially little bag silage (LBS) were offered during farmer trainings and field days in order to catalyze innovation, adoption and dissemination processes of silage technologies with and by small-scale farmers.

Adaptation, adoption and diffusion processes of silage technology and factors influencing these processes were identified for the Yoro area.

Over the last three years, there were annual growth rates of farmers using silage of 91, 57 and 103 % respectively, with presently 67 farmers. In the same period, the quantity of forage ensiled increased by 82, 71 and 135 % respectively, with presently about 3880 tons.

Until 2003, there were only medium and large-scale farmers using mainly the common bunker silo type that involves an initial investment of about US$ 600 for materials and construction (30 t forage capacity). Since 2004, the use of alternative low-cost silo types has been increasing up to presently 50 % (11, 17, 22 % for LBS, earth and heap silo respectively). The present share of small-scale farmers using silo increased from 0 to about 20 %. While until 2002/2003, 91 % of the farmers ensiled maize, the present share is about 65 % with an increasing use of sorghum and mixtures of improved pastures, sugar cane and forage legumes.

In Yoro, the most relevant factors boosting the spread of silage use are forage scarcity and the absence of a forage market, existence of a milk market, promotion of silage technology and technical assistance, presence of farmer associations and innovators who are at the same time key communicators and influentials.

Keywords: Farmer trainings, feeding strategy, forage conservation, silage

Contact Address: Christoph Reiber, University of Hohenheim, Institute of Plant Production and Agroecology in the Tropics and Subtropics
current address: Drosselweg 6, 72501 Gammertingen, Germany, e-mail: chreiber@gmx.de

Improving Livelihoods through Coconut Product Diversification, a Case from Vietnam

MENNO KEIZER

International Plant Genetic Resources Institute, Malaysia

Coconut is a crop of poor land and poor people. Around 96 % of coconut farmers are smallholders tending less than four hectares. These people are marginalised and often do not own their land. Because of limited market opportunities, rural coconut producing families often have little alternative than to sell the raw product, copra, which is a low-value commodity. Diversification of coconut products could reverse this situation coupled with addressing the marketing issues dominating the industry. This research paper deals with a coconut high value product produced by local communities in Vietnam and investigates the marketing chain of gift baskets made from the leave of the coconut tree. The utilisation of the coconut leaves, which otherwise would be a waste product, provides a livelihood opportunity for many rural people in Ben Tre province. Gift baskets have an important socio-cultural value in Vietnamese society. They are widely used for the presentation of gifts for special events at certain times of the year. The production of midrib, i.e. processing of the main vein of the coconut leave, provides an additional or is sometimes the only source of income, especially for the elderly. It is therefore an important activity in the peoples' livelihood. Basket-producers are experienced craftswomen and men. Due to the proximity of the market, the existence of local traders and their competitive edge of producing high quality baskets, they are able to make a decent living. Although local authorities have expressed their concern about reduced productivity of coconut trees because of excessive leave harvesting, there is no hard evidence available at the moment on what the effect of the various harvest methods practised is on the coconut yield. A study into these effects is highly recommended. This could not only lead to improved harvest practices by the midrib producers but could also provide information to policymakers that midrib baskets and coconut production could go hand in hand and would provide an additional livelihood opportunity for many rural families in Ben Tre province.

Keywords: Livelihoods, Market system research, product diversification, sustainability, value chain analysis

Contact Address: Menno Keizer, International Plant Genetic Resources Institute, Po Box 236 Upm Post Office, 43400 Serdang, Malaysia, e-mail: m.keizer@cgiar.org

Assessing and Comparing Income Generation of Livestock Holders in Olancho, Honduras. An Analysis Across Typical Landscapes and Farming Systems

PETER LENTES[1], MICHAEL PETERS[2], DOUGLAS WHITE[2], FREDERICO HOLMANN[2], CHRISTOPH REIBER[3]

[1]*International Centre for Tropical Agriculture (CIAT), Honduras*

[2]*International Centre for Tropical Agriculture (CIAT), Colombia*

[3]*University of Hohenheim, Institute of Plant Production and Agroecology in the Tropics and Subtropics, Germany*

The prolonged dry season (3–6 months) limits livestock production in wide parts of Central America. Responding to drought, livestock holders rely on feeding supplements, (concentrates, molasses) and conserved forage. Many small-scale farmers cease milk production during dry periods resulting in scarcity of cash.

Characteristics of farms across herd sizes (small 1–15, medium 16–70 and large $>$ 71 heads) are compared in terms of land allocation, the use of supplements and conserved forage for livestock in dry and wet season.

Sampling of 86 farms was done in two groups. A random sample along a transect and a targeted sample of positive deviances, farms with known higher level of technification. Most of the income is generated with meat and milk.

Income per head of young stock (sold after 12 months) depended on the amount of milk given to the calves and the length of the lactation throughout the groups. Young bulls (sold after 24 months) bring more among the large producers. Positive deviances earn less with young stock than the others but earn more when producing young bulls.

Along with herd size, the availability of improved pastures rises whereas basic grain production declines. This suggests a more intensive livestock production for larger cattle owners and a more subsistence—oriented system for small producers. But comparing production cost per milking cow for the dry season and the income gained, points out that small farmers (provided that they milk in the dry season) are generating income in a more efficient way. This is partly due to high cost of forage production among large farmers. Small farmers obtain higher prices selling small quantities of milk to the local market. The highest dry season-income per cow was found among the positive deviances.

Improvement of dry season forage availability through stepwise seeding of improved forages and their conservation would thus be an appropriate and effective alternative to increase and sustain cash flow of poor producers. It would enable more of them to milk their cows during fodder scarcity periods.

Keywords: Cash, dry season, Forage, Honduras, Livestock, Socio-economics

Contact Address: Peter Lentes, International Centre for Tropical Agriculture (CIAT), Tegucigalpa, Honduras, e-mail: p.lentes@cgiar.org

Analysis of Small Landowners' Willingness to Accept Conservation Payments in Brazilian Amazonia

NORMA ELY SANTOS, SIEGFRIED BAUER

Justus-Liebig-Universität Giessen, Institute of Agriculture and Food Systems Management, Project and Regional Planning, Germany

Policies designed to enhance forest conservation face various barriers especially when applied in areas inhabited by small landowners because of the long period of time needed to achieve benefits. In case of some communities located in southeastern of Marajo Island, Brazilian Amazonia, it might be possible to obtain gains for environmental services through the forest conservation and sustainable management practices, since the area still maintains a large forest area. However, the implementation of conservation policies would eventually led to a change of the current agricultural methods including slash-and-burn, shifting cultivation, ranching and non-managed logging to others more sustainable. Therefore, the main objectives of this paper are: to assess the monetary amount required by the local households by using the willingness to accept compensation (WTA) approach and, to determine the factors affecting the farmers' decision for setting such values.

Based on a field survey conducted with one hundred farm households in six different communities in southwestern Marajo Island, the study results infer important findings: the payments demanded to give up the current activities are within the two Brazilian minimum wages per ha per year. Households with smaller income use the minimum wage as base for the payments estimates, whereas households with larger income use the cost opportunity approach to calculate the payments estimates.

OLS regression was employed to determine the relations between payments requested, the productive capability, farmer's socio-economic characteristics, and the quality of land and forest area. Tobit regression was employed to evaluate the interdependencies between the area size informed by the farmers and some other explanatory variables. The results of econometric analysis revel that: **(1)** The willingness to accept payments for conservation programs is for the most of farmers shaped by timber and heart of palm production, as well as area of native forest; **(2)** The area available for such program is associated with the area of native forest, the distance to the closest village, the household size and with timber and heart of palm production.

Keywords: Amazonia, forest conservation , land use, sustainable use, willingness to accept

Contact Address: Norma Ely Santos, Justus-Liebig-Universität Giessen, Institute of Agriculture and Food Systems Management, Project and Regional Planning, 35392 Giessen, Germany, e-mail: normaelysantos@yahoo.com.br

Public-private Partnerships in Biotechnology Research and Impacts on Technology Adoption: the Case of Bt Eggplant in India

VIJESH VIJAYA KRISHNA, MATIN QAIM
University of Hohenheim, International Agricultural Trade and Food Security, Germany

The study analyses ex-ante the adoption of transgenic insect-resistant Bt eggplant, developed under a public-private research partnership in India. Eggplant is often described as the "poor man's vegetable", because it is popular amongst small-scale farmers and low-income consumers. Eggplant is attacked by various insect pests, the major one being the shoot and fruit borer, Leucinodes orbonalis Guenée. Farmers' willingness to pay (WTP) for Bt technology is estimated using the contingent valuation method. Given the economic importance of shoot and fruit borer, the average WTP for proprietary Bt hybrids is more than four times the current price of conventional hybrids, but only a quarter of the total economic loss inflicted by the pest. Since the private innovating firm has shared the technology with the public sector, it is likely that public open-pollinated Bt varieties will also be released after a small delay. This is will reduce farmers' WTP for Bt hybrids by 35 %, thus decreasing the scope for corporate pricing policies. Nonetheless, ample profit potential remains, as the mean WTP will remain almost three times higher than the existing price of conventional hybrid seeds. Analysis of factors influencing farmers' adoption decisions demonstrates that public Bt varieties will improve technology access for resource-poor eggplant producers, who currently resort to intensive chemical measures for borer management. Partnership with the public sector might facilitate technology approval process for proprietary technologies, where biosafety procedures are highly politicized, with technology critics trying to block technologies developed by the private sector. The results suggest that public-private partnership can be beneficial for all parties involved.

Keywords: Adoption, Biotechnology, Bt eggplant, Contingent valuation, India, Insecticide use, Public-private partnership, Shoot and fruit borer, Willingness to pay

Contact Address: Vijesh Vijaya Krishna, University of Hohenheim, International Agricultural Trade and Food Security, 70593 Stuttgart, Germany, e-mail: vkrishna@uni-hohenheim.de

An Ex-ante Economic Evaluation of Nutritional Impacts of Transgenic-biofortified Potato in India

DEEPESH PUTHIYAPURAYIL CHANGAT[1], VIJESH VIJAYA KRISHNA[2]

[1]*Humboldt Unversity Berlin, Department of Agricultural Economics and Social Sciences, Germany*

[2]*University of Hohenheim, International Agricultural Trade and Food Security, Germany*

Though proven correlation exists between malnutrition and income poverty, it is well recognised that economic growth alone can not form panacea for under-nourishment. To address this problem an array of approaches is adopted by the policy makers of developing countries. Biofortification of food is a relatively new development that compliments the existing instruments to ameliorate malnutrition problem. It refers to breeding staple food crops for higher nutrient content levels. Protein-energy malnutrition (PEM) is a major type of macronutrient malnutrition in the developing countries, which is characterised not only by energy deficit due to reduction in all macronutrients, but also by a deficit in many micronutrients. From the perspective of welfare economics, the present study addresses the nutritional impacts of a transgenic biofortified crop — protein rich potato or 'protato'; developed by the public research sector of India. The protato, enhanced with a gene from the amaranth plant, has up to a third more protein than traditional potatoes and significantly higher levels of the essential amino acids viz. lysine and methionine. A probe into **(i)** the nature and extent of protein malnutrition in socioeconomic context of India **(ii)** the extent to which the protein rich transgenic potatoes can help ameliorate protein malnutrition, and **(iii)** the consumer attitude and willingness to purchase them, forms the major research objectives. The paper elaborates the research design and includes review of previous studies to examine the impact and direction of various socioeconomic factors of consumer households determining attitude towards genetically modified foods. Using the secondary data, the demand for potatoes is estimated across Indian states with varying levels of per capita income, combining rural and urban population. Methodological aspects of calculating disability adjusted life years (DALYs), employed to measure impacts of PEM are also detailed in the paper.

Keywords: Biofortification, India, Nutrition, Protato, Protein-energy malnutrition, Transgenic potato, Willingness to purchase

Contact Address: Deepesh Puthiyapurayil Changat, Humboldt Unversity Berlin, Department of Agricultural Economics and Social Sciences, Luisenstr. 56, 10099 Berlin, Germany, e-mail: deepeshpc@gmail.com

Determinants of Credit Rationing: A Study of Rural Households in North China

XIANGPING JIA, FRANZ HEIDHUES, MANFRED ZELLER
University of Hohenheim, Institute of Agricultural Economics and Social Sciences in the Tropics and Subtropics, Germany

Compared with the burgeoning urban economy, the situation in rural China can hardly be cheerful. Rural communities suffer from low grain prices, insecure land rights, lack of capital, and the rising costs for education and health. One of the policy instruments of the Chinese government is to address the rising inequalities between urban and rural areas by providing subsidized credit to rural households.
This paper investigates which type of rural households benefit from credit. After a brief overview of rural financial market in China from a historical perspective, we describe the method of data collection and the theoretical and econometric model. Using first-hand survey data of households from North China, a two-stage probability models will be applied to analyse the determinants of credit rationing in both formal and informal credit markets. We model a sequential decision-making process where in the first stage households decide to apply for a loan or not, and in the second stage, state-owned banks as lenders decide to fully or partially grant the requested loan amount or to reject the loan altogether. In the first stage, univariate LOGIT models are used to estimate the probability of applying for loans. In the second stage, we test hypotheses concerning household characteristics that can be observed by the lender to determine the credit rationing decision. To account for selection bias, we use —following models developed James Heckman— the Mill's ratio estimated from the first stage LOGIT models. Two sequential models are estimated: one for the informal and one for formal credit market. This allows us to identify differences in demand and supply behaviour in these two market segments.

Keywords: China, Credit rationing, Rural households

Contact Address: Xiangping Jia, University of Hohenheim, Institute of Agricultural Economics and Social Sciences in the Tropics and Subtropics, Schloß, Osthof-Süd, 70599 Stuttgart, Germany, e-mail: jjoseph@uni-hohenheim.de

Socio Economic Impact of Irrigation Project on Living Standard of Farming Population in North - Syria

SALWA ALMOHAMED[1], WERNER DOPPLER[2]

[1] *University Hohenheim, Agricultural Economoics and Social Sciences in the Tropics and Subtropics, Germany*

[2] *University of Hohenheim, Farming and Rural Systems in the Tropics and Subtropics, Germany*

Rainfall is the main water source for agriculture in the arid and semi-arid areas. The low rainfall and the non constant quantities over the year caused low agricultural yields and consequently low farm and family income of farming communities.
Syria is one of those countries where irrigation plays an important rule to increase the agricultural production. Therefore, many land reclamations projects were conducted through expansion of irrigated areas with building channels. This study investigates the impact of irrigation project in West —Maskana area on the living standard of farming population existing in the area.
75 farming families were randomly selected. 50 farmers were selected from the project area while the other 25 were selected from outside the project area. This stratified random sampling was used as a basis for classification to enable the comparison between project beneficiaries and non-beneficiaries.
The current results of the economic analysis of different farming systems showed that irrigation project has increased the land productivity 9–12 times and consequently the farm income has also increased. Additionally the analysis showed that the contribution of farm income in the family income has increased to reach more than the half of the family income.
The main reason behind this fact is the high level of availability of irrigation water. Therefore, families outside the project area have directed their resources towards off-farm activities. Results showed that the contribution of off-farm income of non beneficiaries farming families in their family income is 71 %.
In general, water availability enhanced the agricultural intensification. Results showed significant differences in crop intensify between different farming systems. Crops intensity indicator was 143 % in the beneficiaries' farmer group while it was only 92 % in the non-beneficiaries farmers group.

Keywords: Farming systems, irrigation projects, Syria

Contact Address: Salwa Almohamed, University Hohenheim, Agricultural Economoics and Social Sciences in the Tropics and Subtropics, Fruwirthstr.12, 70593 Stuttgart, Germany, e-mail: salwa@uni-hohenheim.de

Smallholder Cash Crop Production and its Impact on Poverty in Kenya

ELIZABETH KABURA NYAGA, WERNER DOPPLER
University of Hohenheim, Farming and Rural Systems in the Tropics and Subtropics, Germany

This paper is based on an ongoing research on impact of smallholder cash crops production on living standards under different farm and family conditions. In Kenya, most farmers are small scale producers of cash crops such as tea and coffee. Prior to early 1990's, farmers earned enough income to provide for adequate food, education and good health to their families. These industries have been faced with challenges such as decline in world prices, entry of many competitors in the market including introduction of products that replace the functions of these cash crops. These challenges have negative impacts on competitiveness and market participation of the smallholders. Cash crop production is currently not contributing to alleviation of rural poverty. The daily efforts of the farmers do not trickle back to them but enrich the marketers and buyers. There is therefore a relationship between cash crop production, poverty and hunger among rural families. The paper will highlight issues of resource allocation and use among different groups of smallholder tea and coffee farmers. It will also highlight the relationship between cash crop production and living standards measurements such as food supply and security, family income, health and education. This paper is motivated by the fact that despite the allocation of almost all their resources and time in cash crop production, farmers are ravaging in poverty; unable to get enough food, pay health services and school fees. Most of the land was invested in cash crops and farmers do not have enough land left for food production and other income generating activities. Unemployment is spreading fast because the tea and coffee farms can no longer absorb the growing population which includes the farmers seeking off-farm income and youths who dropped prematurely out of school. The results show differences in resource allocation and use; and levels of living standards among the farming systems. The results show that financial and physical capitals and to some extent human capitals are the main resources that caused variations in both agricultural productivity and living standards in the two farming systems. Analysis has been done using econometric models.

Keywords: Kenya, low living standards, poverty, smallholder cash crops production

Contact Address: Elizabeth Kabura Nyaga, University of Hohenheim, Farming and Rural Systems in the Tropics and Subtropics, Fruwirth Strasse 12, 70599 Stuttgart, Germany, e-mail: kabura@uni-hohenheim.de

Poverty (GTZ)

Agricultural Research Priorities That Can Foster Prosperity and Reduce Poverty in Nigeria

MICHAEL ALATISE

Federal University of Technology, Agricultural Engineering, Nigeria

The prevailing social conditions in Nigeria present a startling paradox due to their robust endowment in natural and human resources not being matched with the level of poverty of the people. The most difficult challenge facing Nigeria today is poverty reduction to foster sustainable socio-economic growth. Africa remains a rural society, which largely depends upon aggriculture and pastoralism and Nigeria exemplifies this assertion in all ramifications. Thus the main objectives of this paper are to **(1)** evaluate the country's land and water resources, the methods of agricultural practice and its past and present agricultural programmes; **(2)** highlight the much desired agricuculral research challenges and little efforts made in this area and **(3)** establish long-term partnerships among reseachers,practioners and end-users. Various programmes that set-up to combat poverty were discussed and causes for their failures were identified. The reseach challenges include the following: (1) data collection, collation, storage and retrival particularly on (climatological, hydrological, hydro-geological), and crop area survey and machinery; (2) study of crop water requirements and irrigation scheduling to include: (a) evaluation of ET models in different ecological zones of Nigeria and (b) crop yield response to irrigation water management, (3) classifications of soil types in the different ecological zones and (4) design and fabrication of appropriate machines for the various farming operations. Finally, the paper calls for education and enlightenment of the rural community, the creation of an environmen where new ideas can find expression, and integration of , land and water resources for agricultural and rural development.

Keywords: Aecological zones, ET models, hydro-data collection, poverty reduction, water resources

Contact Address: Michael Alatise, Federal University of Technology, Agricultural Engineering, Dept. of Agricultural Engineering Fed. Univ. of Technology, 340001 Akure, Nigeria, e-mail: micalatise@yahoo.com

Analysis of the Implementation of Governmental Programs for the Development of marshlands and Valley Lowlands in Southern Rwanda

GODIHALD MUSHINZIMANA
University of Bonn, Department for Economic Sociology, Germany

Due to an immense growth in population and a high population density combined with an extensive production level as the result of the subsistence economy, the Rwandan government was forced to cultivate its remaining land resources in the past, namely the marshlands that comprised approximately 12 per cent of the country's usable agricultural area. An intensive cultivation of these marshlands is to be achieved primarily through cooperative community usage, the introduction of new cultivation methods (multicropping and agrosilvopastoral systems), and the establishment of microfinancing institutions. Apart from assuring food security, the exploitation of marginal, especially erosion-threatened hillsides is meant to be prevented under the aspect of ecological considerations. The question remains open whether the social situation of the small farmers in the wetlands has improved for those who have been living there or for those who were settled anew in some parts, in order to better living conditions with regard to social care and agricultural infrastructure. No explicit socialeconomic studies have been carried out up to now. It is the aim of this research study is to analyse the political, administrative and social implementation with regard to the consequences of this development policy. Based on the sociological approach of implementation theory the governmental program, its characteristics and development will be described; on the one hand the implementation by the responsible agencies will be analyzed, on the other hand the decision framework of the farmers by regarding the structure of their farm enter-prises and by undertaking a social structure analysis. The research project is designed as a comparative study of two reclaimed marshlands. Between September and December 2005 structured interviews, group discussions and guided expert inter-views were carried out in 70 households in the marsh districts Rugeramigozi and Base respectively. The work was conducted in close cooperation with the PASI-Project Group of the University of Mainz (Prof.Jörg Grunert), with the Agricultural Department of the National University in Butare, which has a strong focus on production-technical aspects, and in coordination with German Agro Action.

Keywords: Implementation, Marshlands, Valley Lowlands

Contact Address: Godihald Mushinzimana, University of Bonn, Department for Economic Sociology, Nussallee 21, 53179 Bonn, Germany, e-mail: mushinzimana@agp.uni-bonn.de

Rice Market under Halfway-liberalised Economy in Myanmar: Structure, Conduct and Performance Approach

THEINGI MYINT, LILA KARKI, SIEGFRIED BAUER

Justus-Liebig-University Giessen, Institute of Agriculture and Food Systems Management, Project and Regional Planning, Germany

Rice plays an important role in Myanmar's economy as an staple food and high amount of foreign exchange earning comes through export. The agricultural economy of Myanmar has been under transition from a planned to a market system since late 1980s. Two liberalisations of rice marketing had been done in 1987 and 2003. The first liberalisation implemented by allowing free domestic marketing and private export of some agricultural products except rice. Rice procurement and rationing systems were abolished under the second liberalisation. However, the government is still not undertaking full-scale rice export deregulation actually. Therefore, the rice marketing system in Myanmar works within the boundaries and limitations of a halfway-liberalised economy which triggers questions about the structure, conduct and performance of rice marketing system. In this study, the general SCP (Structure, Conduct and Performance) approach is adapted, which allows for feedback relationships, competitive behaviour (conduct) of firms and performance (in terms of price, transaction cost, etc.) that might influence the market structure elements by analysing the secondary and primary market survey data of rice surplus and deficit regions. Market structure describes the environment and the characteristics of a market that exercise strategic influence on the nature of competition and pricing. According to the findings, dimensions of rice market structure seem to be competitive market however government intervention on supply side exists as the land policy tightly control in paddy production and procurement system as well. Market intermediaries set the rice price as prevalent market even though they are not allowed to access the international market as export is monopolised by government institutions. Therefore, the rice market performance indicates lower retail price share to producers from the results of high marketing margins along the channels across rice markets taken in this study. The results show an idea intended for the rice market that the current policy environment might develop by deregulation of land policy in supply side along with getting access the international rice market in demand side to become efficient competitive rice market in Myanmar.

Keywords: Halfway-liberalised economy, Myanmar, rice market, SCP approach

Contact Address: Theingi Myint, Justus-Liebig-University Giessen, Institute of Agriculture and Food Systems Management, Project and Regional Planning, Senckenbergstr. 3, 35390 Gießen, Germany, e-mail: theingi.myint@agrar.uni-giessen.de

Pineapple Against Poverty?: Market Opportunities, Technological Development and Social Stratification in Southern Benin

ROCH MONGBO[1], ANNE FLOQUET[2]
[1]*University of Abomey Calavi, Department of Economy, Benin*
[2]*Cebedes NGO, Benin*

Over the past 10 years in southern Benin, pineapple production has been going through a tremendous development following a rapid increase in local and regional demands and a relative success of a few agricultural and trade entrepreneurs in sizing niches on European markets. This is considered as a real blessing for this part of the country where the agrarian development over the century (palm trees economy controlled by the elders, failure of state agricultural services to promote a sustainable farming system and a cash crop as cotton in the central and northern part of the country, important development of land market by the end of the 1980s to the benefit of urban ad middle class population, etc.) has generated soil exhaustion, over fragmentation of family farms, rampant poverty and vulnerability of small farmers and massive migration to Lagos and Cotonou. This paper presents part of the results of empirical investigations conducted in 2004 and 2005 on the circumstances, modalities and consequences of the recent development of a pineapple economy in southern Benin. The research was conducted in 3 villages representative of the agro-ecological variety of the pineapple production area. Qualitative methods were combined with a quantitative survey on a randomly selected sample of farmers. The results presented and analysed in this paper start with a short description of the various strategies and coalitions of actors (farmers and their organisations, merchants, inputs sellers and agricultural extension services) that have ended establishing a commodity chain 'filière ananas' in the southern Benin with marginal if any intervention of the state. Then, based on the empirical data, the paper presents and analyses the technological development at farm level, the strategies of farmers to manage farm labour, activity systems and access to inputs and market. The paper pays particular attention to the social stratification induced by these transformations and the challenges therein for researchers and policy makers.

Keywords: Cash crop, commodity chain, endogeneous institutional innovation, pineapple, stakeholder networks

Contact Address: Roch Mongbo, University of Abomey Calavi, Department of Economy, Socianthropology and Communication, Cotonou, Benin, e-mail: rmongbo@intnet.bj

Refinement of the Malaysian Forest Certification Scheme MTCC with Regard to the Requirements for Public Procurement of Tropical Timber of the City of Hamburg

REINHOLD GLAUNER[1], ULRICH BICK[1], ANDREAS KNOELL[2]

[1]*Federal Research Centre for Forestry and Forest Products, Institute for World Forestry, Germany*

[2]*University of Hamburg, Wood Science, Section World Forestry, Germany*

Global trade with forest resources, especially between developing and industrialised countries, often resulted in an unbalanced distribution of profits and negative consequences for the local population and environment in originating areas. Reliability and credibility concerning social, ecological and economical sustainability therefore are most important features of certification schemes, here with regard to forest resources. In worldwide constraints towards sustainable forest management (SFM) in tropical regions a few national forest certification schemes were developed in recent years. Amongst them the Malaysian Timber Certification Council (MTCC) which follows a phased approach in line with guidelines of the International Tropical Timber Organisation (ITTO). MTCC is an independent non-profit organisation established to plan and operate a voluntary national timer certification scheme in Malaysia. The current scheme in use, the Malaysian Criteria & Indicators 2002 (MC&I 2002), has undergone strong revisal in nationwide fieldtests in 2004. The revised standard (MC&I 2002, version 2004) aims for compliance with the principles of the Forest Stewardship Council (FSC). The Free and Hanseatic City of Hamburg (FHH) implemented a policy to restrict the import and use of tropical timber to sources which are certified under internationally accepted certification schemes. This includes an evaluation of existing certification schemes and a definition of the specific requirements of FHH concerning SFM. The guidelines for public procurement of tropical timber emphasise the need for credible criteria to demonstrate that the resources derive from legal and sustainable managed sources. Based on former discussions between MTCC and FHH a joint project is launched in 2006. The Federal Research Centre and the University Hamburg will provide scientific support for the evaluation and refinement of the revised standard. Specialists from both countries will form a joint project team that will work independently in cooperation with MTCC and other relevant organisations in Malaysia to assess and refine the given standard. This includes the development of additional indicators and verifiers, if necessary.

Keywords: Hamburg, Malaysian Timber Certification Council, national certification initiatives, sustainable forest management

Contact Address: Ulrich Bick, Federal Research Centre for Forestry and Forest Products, Institute for World Foresty, Leuschnerstraße 91, Hamburg, Germany, e-mail: bick@holz.uni-hamburg.de

Prosperity and Poverty among Cotton Growers in Benin — Potential Contributions of a New Partnership among Stakeholders Within the Value Chain

MUTLU PETRA[1], ANNE FLOQUET[2]

[1]*GTZ, Pro Cgrn, Benin*

[2]*Cebedes NGO, Benin*

Cotton has been an important source of income and capital accumulation for farmers in northern Benin during two decades. Visible signs were investments in housings, expansion of cultivated areas in cash and food crops and investments from cotton growers organisations in collective goods, school buildings and community teachers for example. Nowadays many farmers who are growing cotton draw a negative income out of it. They go on with this crop because it is the only way to have access to inputs on credit and to get some "one shot" cash. Negative effects of impoverishment are lack of farm investment, soil fertility depletion, dependency on child farm work, dissension among cotton growers organisations and break up of contracts among actors within the value chain.

We will present an on going experience where the incentive for reversal is coming from the last links within the value chain. A large garment firm in Germany, arguing on social responsibility, designed a public private partnership with GTZ as a public development agency, for promoting cotton that is environmentally sustainable, socially responsible and economically profitable for cotton farmers in three different African settings (Burkina Faso, Benin and Tanzania).

In Benin, about 10.000 farmers, one input dealer and one ginner agree on production standards and monitoring criteria that allow for obtaining a label CmiA and for benefiting from specific trading arrangements. Support is given in form of additional training and extension to farmers' groups engaged in the process as well as for building contractual arrangements among partners. Monitoring of progress is being partly performed by participants in the process and partly by external agencies. Each lint cotton ballot leaving the country and produced within the specific arrangement has a "passport" describing the conditions of its production. It is expected that training and self monitoring on one hand, reshaping of contractual arrangements for timely access to input and cotton payment will have immediate positive effects on farmers' performances.

Keywords: Benin, cotton, public private partnership, value chain

Contact Address: Anne Floquet, Cebedes NGO, 02 Bp 331, Cotonou, Benin, e-mail: uniho@intnet.bj

Approaches and Impacts of Participatory Irrigation Management (PIM) in Complex, Centralized Irrigation Systems — Experiences and Results from the Jordan Valley

HANS JOCHEN REGNER[1], AMER Z. SALMAN[2], HEINZ-PETER WOLFF[3]

[1]*German Technical Cooperation (GTZ), Project Water Resource Management for Irrigated Agriculture, Jordan*

[2]*University of Jordan, Faculty of Agriculture, Jordan*

[3]*University of Hohenheim, Farming and Rural Systems in the Tropics and Subtropics, Germany*

Participatory Irrigation Management (PIM) is a key term in the toolbox of current approaches to improve the efficiency and performance of water resource management. Experiences from several countries indicate that introducing participatory elements in the relationship between decision makers on water resources and end users of water is an essential process in the complex set-up of successful water resources management. The differences between the applied participatory approaches support the assumption that PIM cannot be transferred from one situation to another without modifications. Published guidelines on elements and procedures in participation put their focus on general applicability, but the successful implementation of PIM in a specific case crucially depends on its sensible adaptation to the local situation.

Water resource management in the Jordan River's east bank underwent significant changes since the 1960s and became a highly centralised irrigatiion system under the control of the governmental Jordan Valley Authority (JVA). The social structure of the farming population developed alongside the reorganisation, but weakened tribal bonds in favour of the economic independence of individual families. Efforts towards an improved utilisation of water by introducing participatory elements in water resources management thus have to cope with complex incentive structures of individuals on the level of farmers' communities and within the administration. The implementation of a concept, which relies on four years of analyses on socially acceptable mechanisms in the Jordanian context and the evaluation of former - less successful - approaches, now yield its first positive results. Major economic effects are decreasing maintenance costs of the pressurized conveyance system, a higher security of water supply through the therewith improved reliability of the system and the increase of cultivated areas due to a lower share of buffer zones within irrigation plots, which were a part of farmers' reaction against the risk in water supply. Major social effects originate from the improved and more transparent communication structures, which reduce the number of conflicts between farmers and the need for interventions of governmental authorities in local disputes.

Keywords: Jordan, participatory irrigation management, PIM

Contact Address: Heinz-Peter Wolff, University of Hohenheim, Farming and Rural Systems in the Tropics and Subtropics, Fruwirthstraße 12, 70599 Stuttgart, Germany, e-mail: hpwolff@uni-hohenheim.de

Managing for Development Results — A Baseline for Impact Monitoring on Poverty. Case Study in Sub-saharan Africa, Niger

SILVIA MARTIN HAN[1], MELANIE DJÉDJÉ[2], JESSICA FRÜHWALD[1]

[1]*Humboldt University Berlin, Advanced Training in Rural Development, Germany*
[2]*Consultancy for International Cooperation, Western and Eastern Africa, Germany*

The German cooperation in Niger has committed itself to contribute to the fight against poverty (Programme de Lutte contre la Pauvreté, LUCOP) as outlined in the national PRSP. Thus, a regular follow up of the results due to the programme's interventions became a necessity. A results based monitoring system was initiated according to the new orientation on impacts of the international development policy.
The present study delivered the baseline for the results based monitoring. Main challenges met were the identification of linkages between the national poverty strategy and the programmes intervention as well as the national and international definitions of poverty and those of the local people. For what results the programme can be made responsible and how do interventions of other projects and organisations influence locally the programme's impact?
The OECD-DAC Model of results chains (slightly adapted by GTZ) and the DFID Model of the four dimensions of poverty helped to tackle the task. In identifying the underlying hypotheses of the programme's strategy through the results chains, differences between programme's outputs, outcomes and impacts became evident and measurable through indicators. Then linkages could be drawn to indicators of the national strategy.
The programme's key indicators formed the reference for the field study, which was carried out in the two regions of the intervention zone. The methodology applied comprised semi-structured interviews, adapted PRA tools and observation. Villagers were invited to define themselves categories of poverty and means to measure well being.
Main findings were: Dependency on agriculture is considered the principal cause of poverty (income, access to production factors and services). Poverty is always influenced by a combination of factors belonging to the four dimensions of poverty. Thus to fight against poverty it is necessary to be aware that poverty is a multidimensional phenomenon. Furthermore, consequences of extreme poverty do not restrict to man but impact directly the natural surroundings by destroying the environment (excessive tree cut, selling wood), basis for future subsistence.
In summary, the intention of the study is to make a practical contribution to reinforce the impact monitoring system of development programmes for poverty alleviation in rural areas. Thus effective use of current resources should lead to more visible and successful achievement of the MDG.

Keywords: Food security,monitoring, evaluation, poverty assessment, rural areas

Contact Address: Silvia Martin Han, Humboldt University Berlin, Advanced Training in Rural Development, Straße des 17. Juni 145, 10623 Berlin, Germany, e-mail: silvia.martin.han@gmx.de

Impact of Malaria on Food Production in the Western Highlands of Cameroon

NDAMBI BENINWECK ENDAH[1], OGHAIKI ASAAH NDAMBI[2]

[1]*University of Hohenheim, Germany*
[2]*IFCN Dairy Research Center, Germany*

Parasitic diseases contribute immensely to undermining the health status and jeopardising the economic development of African nations. 515 million cases of clinical malaria where reported globally in 2002 with more than 80 % in Sub-Saharan Africa. Experts estimate that a child dies every 30 seconds from malaria in Africa. WHO reports rank Cameroon endemic, with an incidence rate of 45.96‰ in 1998. Country statistics revealed incidence values of 83.6 % in 1984, 90.5 % in 1985, and 67.5 % in 1986. The incidence remains high because of deteriorating health systems, growing drug resistance and insecticide resistance. An epidemiological study of malaria was carried in the agricultural region of Dschang, Cameroon. The study was done in 2 phases; collection of blood samples by the finger prick method from a total of 515 persons, and data collection from the Dschang District Hospital laboratory. Of the 515 persons, 79(15.3 %) were positive for malaria, ranking Dschang as meso-endemic for malaria. From our studies, transmission occurs through out the year with parasitemia increasing during the rainy months. The month of August had the highest Plasmodium Index of 17.5 % from our tests, while July and August had the highest Plasmodium Index for the patients who visited the hospital. These months are the peak periods for final weeding and harvesting of most staple crops in the rainy season. During the dry season, mosquito density is highest along rivers, which are fertile farming areas where farming is done. Malaria causes weakness of patients thereby reducing labour output, causes interruption of the production cycle and also causes deviation of funds from farm inputs to treatment costs for malaria. Malaria is therefore a great hazard to food security and a hindrance to poverty alleviation since poor farmers in agricultural production zones are highly vulnerable. Malaria remains a big problem as no effective vaccine has yet been developed against it. The use of drugs is limited due to costs incurred and worse still, it is not a guarantee, since the farmer remains exposed to predisposing factors promoting transmission and re-infection.

Keywords: Cameroon, Food Security, Hazard, malaria

Contact Address: Ndambi Beninweck Endah, University of Hohenheim, Fruwirthstrasse 7 - 4304, Stuttgart, Germany, e-mail: matni3@yahoo.com

Towns as a Motor for Economic Development — Trends Observed in Periurban Areas Around Mid Sized Cities in Benin and the von Thünen' S Framework

ANNE FLOQUET

Cebedes NGO, Benin

City growth strongly affects enterprises of the food sector in their hinterlands through pull and push effects. For several decades, scholars have been debating on the role played by small market towns on rural areas and on their impact on growth. Indeed, recent poverty studies reveal that the part of poor people in Benin has been increasing in rural areas but not in urban and peri-urban areas. In this context, the research programme ECOCITY is studying changes in agriculture and related processing activities at the interface between mid sized towns in Benin and Senegal and their hinterlands.
The German economist von Thünen (1783–1850) has been a pioneer in developing a theoretical framework on how cities influence spatial arrangements of agricultural productions. According to it, land use is patterned in concentric circles.
Around Abomey, such concentric circles can nowadays be found, due to processing microfirms rather than to the crops which had previously provided them with raw materials. Such microenterprises in the food processing sector root in traditional skills and expand in response to a growing urban demand; their proximity to each other is a source of positive externalities so that their trends to clustering should remain. High impoverishment of soils in the near hinterland constraints their exploitation, even if new trends in the use of city wastes can be observed.. High value crops can be found further from the city in high potential areas like river banks but have to compete with products from long distance marketing networks already supplying the city.
Historic inheritances and influence of a large network of long distance markets therefore blur the expected concentric circles of high value crops at the periphery. In such a context, evidence seems to be lacking for restraining the spatial expansion of the city and protect periurban farm activities, even if these activities provide employment for thousands of periurban and urban inhabitants.

Keywords: Cluster of firms, periurban agriculture, town, von Thünen

Contact Address: Anne Floquet, Cebedes NGO, 02 Bp 331, Cotonou, Benin, e-mail: uniho@intnet.bj

Animals and Production Systems

Animal Genetics and Breeding

Strategy to Assess Genetic Diversity and Conserve Vietnamese Animal Genetic Resources Based on Molecular Parameter

NGO THI KIM CUC

Georg-August-Universität Göttingen, Institute of Animal Breeding and Genetics, Germany

Vietnam is one of the countries, which is richest in biodiversity in the world. There are 50 local breeds known. They show specific adaptation to climate or disease and the local low input - low output production system. Despite their importance, their population sizes have been decreasing, some breeds are dangerous and threatened of extinction. The erosion of local breeds could be linked with the loss of valuable genetic variability and unique characteristics.

Moreover, identification of the local breeds in the country is mainly based on: their original areas, names called by local people and their phenotypic characteristics. According to definition for breed of FAO, there might be more breeds to be discovered in next years. Therefore, correct identifications of populations to conserve need to be an attention. Microsatellite was assessed to be very useful to assess genetic diversity and identify breeds for conservation.

Microsatellites markers which developed by the European Commission — funded project of Development of Strategy and Application of Molecular Tools to Assess Biodiversity in Chicken Genetic Resources (AVIANDIV), Institute of Animal Breeding and Biotechnogy at Hohenheim University - Germany and the Project of Animal Biodiversity Assessment in Vietnam (BIODIVA) funded by France as well as Food and Agriculture Organization of United Nations (2004) - Secondary guidelines for development of national farm animal genetic resources management plans: measurement of domestic animal genetic diversity (MoDAD): Recommended microsatellite markers should be used to assess genetic diversity of chickens, pigs and ruminant, respectively.

The result obtained will be useful to identify breeds for efficient conservation measures and to monitor genetic variation within and between conservation flocks. It enables to contribute objective information on the global assessment and evaluation of the state of the world animal genetic resources.

Keywords: Animal genetic conservation, microsatellite, Vietnam

Contact Address: Ngo Thi Kim Cuc, Georg-August-Universität Göttingen, Institute of Animal Breeding and Genetics, Albrecht-Thaer-Weg 3, 37075, 0551 Göttingen, Germany, e-mail: cucngokim@yahoo.com

The Role of Meat Quality in Conservation of Indigenous Endangered Farm Animals: Case Study of Endangered Goose Breeds "Diepholzer Gans"

SARAH SAKINEH ZARIN, NIELS KOHLSCHÜTTER, ULRICH KÖPKE
University of Bonn, Institute of Organic Agriculture, Germany

Erosion of livestock genetic resources increased since industrialisation in agriculture. Today 30 % of the farm animal breeds are at risk of being lost. This is mainly caused by replacement of local indigenous breeds of livestock with high productive hybrid breeds. Livestock genetic resources form the pool of diversity available to meet the increasing global demand for food and agriculture. "Diepholzer Gans" is an indigenous endangered breed of goose, which originated in Germany. Its performance and features have been compared with a hybrid breed of the company "Eskildsen" as a reference, especially for meat quality, under identical feeding and housing conditions. The aim was to recognise parameters that support the conservation of the endangered breed of goose by means of "on-farm" strategy and marketing on niche markets, as one of the most cost efficient conservation strategies. The influence of breed type was evaluated by determining body weight gain, feed intake, feed conversion ratio, health status, carcass value and meat quality of the geese. Significantly higher body weight gain (6.3 kg living weight for Eskildsen and 5.6 kg for Diepholzer breed) and lower feed conversion ratio for the hybrid breed were determined. Dressed body, breast and thigh weight were significantly lighter for the Diepholzer breed. The muscle fraction in the breast and thigh was higher for the Eskildsen breed. No differences were found in the electric conductivity and pH value except at 20 minutes post-mortem in breast muscle when the conductivity was higher for the Diepholzer. Colour scale values; L*, a* and b* of the two breeds were not significantly different. The drip loss of fresh breast muscle was significantly higher for the local breed. The type of breed did not affect freezing loss, cooking loss and the shear force. In conclusion the "Diepholzer Gans" gained 12% less body weight and there were no relevant differences in meat quality. Nevertheless marketing of the Diepholzer based on better quality to encourage conservation by means of "on-farm" strategy is impossible. But, using the Diepholzer breed on niche markets in combination with other aspects that indicate a regional product, make this strategy possible.

Keywords: Diepholzer goose, indigenous endangered breeds, livestock genetic resources, meat quality, on-farm conservation

Contact Address: Sarah Sakineh Zarin, University of Bonn, Institute of Organic Agriculture, Bonn, Germany, e-mail: sa_zarin@yahoo.com

The Case for the Conservation of Sudanese Kenana and Butana Cattle Breeds

LUTFI MUSA[1], KURT-JOHANNES PETERS[1], MOHAMED KHAIR AHMED[2], BIRGIT ZUMBACH[3]

[1]*Humboldt-University Berlin, Department of Animal Breeding in the Tropics and Subtropics, Germany*

[2]*University of Khartoum, Genetics and Animal Breeding, Sudan*

[3]*University of Georgia, Athens, Department of Animal and Dairy Science, United States*

Kenana and Butana in Sudan are characterised to have the best milk potential among local breeds in the country. Under improved feeding and management Kenana and Butana yield on average 1500 kg milk and up to 4500 kg per lactation. Unfortunately, their numbers are very small compared to other less productive types of cattle. These two breeds are now subjected to fast genetic dilution due to different factors.

Their crossbreeding with Friesian is gaining ground very quickly. Many farmers have realised that crossbreeding Friesians with Butana or Kenana give better milk yield than crossing with other local breeds. Therefore, the demand for Butana and Kenana to produce crossbreed for improved system is very high.

Drought, famine and most recently civil war in Western Sudan have led to the displacement of millions of mostly nomadic people. Displaced people who have managed to keep some of their animals (generally Baggara cattle which are poor milkers) during the droughts have done so because they moved early on to riverian areas, the homeland of the Kenana and Butana cattle.Now,crossbreeding is happening between Baggara and the better breeds of Kenana and Butana cattle.

This has led to widespread concern over the fate of Butana and Kenana types and to efforts for conservation of these strains for both present and future use. Conservation methods (e.g. in-situ and ex-situ) are discussed and the possibilities for in-situ conservation (on farm conservation) based on establishing sustainable improvement breeding programme involving the cattle owners breeding goals and practices are addressed.

Keywords: Butana, cattle, conservation, Kenana, Sudan

Contact Address: Lutfi Musa, Humboldt Universität Zu Berlin, Berlin, Germany, e-mail: lutfimusa@hotmail.com

Genetic Variety of the Different Vietnamese Local Chicken Breeds and Effect on the Fads1 and Fads2 Genes

NGUYEN THI KIM KHANG[1], DANYEL JENNEN[1], LOTHAR MENNICKEN[1], DAWIT TESFAYE[1], SIRILUCK PONSUKSILI[2], KARL SCHELLANDER[1], KLAUS WIMMERS[5], MICHAEL HOELKER[1]

[1]*University of Bonn, Institute of Animal Science, Animal Breeding and Husbandry Group, Germany*

[2]*Research Institute for the Biology of Farm Animals (FBN), Germany*

Egg yolk fatty acids are a functionally important source for the ω6 and ω3 polyunsaturated fatty acids. Decreasing the ω6:ω3-PUFA ratio to 5:1 in human diets is considered to improve human health with respect to the risk of cancer, adiposity, diabetes and cardiovascular diseases. Genetic polymorphism of the Vietnamese local chicken breeds and European breeds are still poorly studied as DNA markers which could be used to reduce the ω6:ω3-PUFA ratio. Members of the FADS family are considered the most crucial enzymes involved in the biosynthesis of the fatty acids. They introduce double bonds[n1] between defined carbons resulting in the desired fatty acid modifications and thereby, they change the fatty acid profiles on chicken. The objectives of this study were to identify, clone and show the expression of the functional candidate genes FADS1 and FADS2 and to compare potential polymorphisms for distinguishing breeds of different origins. Therefore, unrelated laying hens of Vietnamese local chicken breeds Ri, H'mong, Te, Noi and Ac as well as an European breed were used for this study. Liver tissue was collected to identify the candidate genes. The chicken cDNA sequence of FADS1 and FADS2 was obtained and SNPs located within both genes. In addition, real time PCR was performed to quantify the expression of the FADS1 and FADS2 genes in the different breeds. The results show that no polymorphisms were found in FADS2, while two were found in the FADS1 at position 391 (C->A) and 468 (C->T). The later showing an amino acid change from Val to Ala.The Ri and Ac chickens are dominant heterozygous (CA and CT, respectively), whereas Te, H'mong and Noi chickens are homozygous (CC) for both SNPs. The expression of FADS2 is stronger than FADS1 and the highest levels for both genes are observed in Te chicken. (This project was supported by the Federal Ministry of Education and Research, BMBF grant VNB02/B07, Germany).

Keywords: ω3, ω6, chicken, FADS1, FADS2, polymorphisms

Contact Address: Klaus Wimmers, Research Institute for the Biology of Farm Animals, Molecular Biology Research Division, Wilhelm-Stahl-Allee 2, 18196 Dummerstorf, Germany, e-mail: wimmers@fbn-dummerstorf.de

Design of a Village Breeding Programme for a Llama Population in the High Andes of Bolivia

MARIA WURZINGER[1], ALFONS WILLAM[1], JAVIER DELGADO[2], MICHAELA NÜRNBERG[3], ANNE VALLE ZÁRATE[3], ANGELIKA STEMMER[3], GUIDO UGARTE[4], JOHANN SÖLKNER[1]

[1]*University of Natural Resources and Applied Life Sciences Vienna, Department of Sustainable Agricultural Systems, Austria*

[2]*University of Hohenheim, Institute for Animal Production in the Tropics and Subtropics, Germany*

[3]*Universidad Mayor de San Simón, Bolivia*

[4]*Asociación de Servicios Artesanalesy Rurales (ASAR), Bolivia*

Llama husbandry is of high importance for the Bolivian high Andean agro-ecosystem and its inhabitants. Due to their unique adaptation to high altitude conditions, llamas are traditionally a cornerstone of the Andean farming system. Despite the harsh environment, they provide the household with fibre, meat and dung and males are used as pack animals. Although llamas contribute to a large extent to the income of many Bolivian households, there is no national breeding programme in place. Initiatives for genetic improvement are rarely found and are usually carried out by NGOs or research stations. Farmers in the Province of Ayopaya in the Department of Cochabamba formed an organisation with the aim of improving agricultural production and especially llama husbandry. In this study a detailed outline of a breeding programme with a focus on organisational and technical details is described. Facing constraints like illiteracy of farmers, bad infrastructure and lack of finances a simple breeding programme is set up. All calculations are carried out with the computer programme ZPLAN, which is based on a deterministic approach. The breeding goal is a higher fleece weight while keeping the fleece quality at the current high level. Greasy fleece weight and fibre diameter are identified as main selection criteria. Mass selection of males is based on own performance. Selected males are either exchanged between farmers and used in the herds or are kept in a central mating centre owned by the breeders‘ organisation during the mating season. Different scenarios with only intra-herd use, only using the central mating centre or different combinations are compared in terms of genetic gain and expected increase of inbreeding.

Keywords: Bolivia, breeding programme, llama

Contact Address: Maria Wurzinger, University of Natural Resources and Applied Life Sciences Vienna, Department of Sustainable Agricultural Systems, Gregor Mendel Straße 33, 1180 Vienna, Austria, e-mail: maria.wurzinger@boku.ac.at

West African Dwarf Goat Production under Village Conditions: 1. Characterisation and the Establishment of Breed Standards

SAIDU OSENI, BABAFUNSO SONAIYA, GALMAN OMITOGUN
Obafemi Awolowo University, Department of Animal Science, Nigeria

The role of small ruminants in poverty alleviation and their contribution to sustainable livelihoods especially in rural areas have been demonstrated by several R&D programmes in Sub-Saharan Africa. Proposals have been made for the evolvement of purebreeding schemes for the conservation of the genetic pool which the WAD goat represents. A crucial starting point however, is the characterisation and the establishment of breed standards for WAD goats under village conditions. So far, there has been little progress in this regard on account of the difficulties in establishing on-farm data recording schemes. Also, comprehensive studies relating to the within breed diversity among WAD goats are rare. Such studies will show details about performance and morphometric characteristics of WAD goats in their native environment. All these represent vital information needed for breed characterisation and the establishment of breed standards. A conceptual framework for the attainment of these objectives is presented, with illustrations drawn from an on-going R&D project involving WAD goats. The framework is hinged on on-farm livestock performance recording systems. Project inception embraced awareness campaigns and sensitisation of farmer groups, where the scope and rationale for the studies are discussed. Pilot villages are randomly selected from different ecozones where WAD goats are raised in Southwestern Nigeria. Research methodology involved structured household interviews combined with fortnightly visits and the establishment of on-farm recording schemes. Data on performance, morphometric and qualitative traits at all ages are recorded. Direct observations and documentation of all aspects of the rural setting relating to the raising of WAD goats — farming systems and feed resources - are documented. With data accumulation, computer databases are created for data management, analysis, interpretation/information retrieval. Analysis of data helps to derive productivity indices under village conditions. The framework involves some feedback mechanism to provide farmers with innovative techniques in goat management and simple selection schemes within each village. Overall, the framework will facilitate the design of appropriate genetic improvement measures geared towards boosting the productivity of WAD goats under smallholder units.

Keywords: Breed standards, characterisation, livelihood, on-farm, west African Dwarf goat

Contact Address: Saidu Oseni, Obafemi Awolowo University, Department of Animal Science, Department of Animal Science, Faculty of Agriculture Oau Ile-Ife, 220005 Ile-ife, Nigeria, e-mail: soseni@oauife.edu.ng

Community-based Management of Animal Genetic Resources: Experiences in Implementation of Participatory Processes

WORKNEH AYALEW[1], ADAM DRUCKER[2], CLEMENS WOLLNY[1], OLOROUNTO D. KOUDANDE[3], FAUSTIN VIDOGBENA[4], HIPPOLYTE DOSSA[4], LEMMA GIZACHEW[5], ULFINA GALMESSA[7]

[1]*International Livestock Research Institute (ILRI), Ethiopia*

[2]*Charles Darwin University, School for Environmental Research, Australia*

[3]*National Institute for Agricultural Research, Benin*

[4]*Georg-August-University Göttingen, Animal Breeding and Husbandry in the Tropics and Subtropics, Germany*

[5]*Oromia Agricultural Research Institute, Ethiopia*

Community-based management (CBM) of existing animal genetic diversity in developing countries has been argued to support the improvement of the livelihoods of poor livestock keepers while also ensuring the conservation of the genetic resources. ILRI in collaboration with partner national institutions in Benin Ethiopia and Kenya has been implementing a 3-year CBM research project since September 2004 by developing a framework to fully engage communities in the management of these resources. CBM involves series participatory processes to elicit livestock development priorities of target communities in tandem with preferences of market actors, and to design as well as implementation appropriate interventions that serve community needs while also improving effectiveness and sustainability livestock genetic improvement activities through collective action. In the context of the Convention on Biological Diversity (CBD), participation also entails application of the principle of Prior Informed Consent (PIC) in research involving biological material and indigenous knowledge. The project already started to create essential community structures as a basis to operate. This paper critically looks in to what constitutes a community in the context of this project and examines experiences with implementation of these participatory processes. The participatory processes opened up broad opportunities to identify livestock development priorities, elicit and incorporate local knowledge and enhance collective action of community members. However, participatory exercises and community preferences were shaped by previously established priorities of the project and perceptions of researchers. These highlighted the need for capacity building at community level and encouraged collective action. In terms of PIC, the project countries have not yet developed the essential institutions that would implement them, and at the community level there is need for capacity building for the communities to fully grasp the implications of PIC. It was therefore concluded that lessons in participatory processes are learned by doing.

Keywords: AnGR, CBD, CBM, community participation, PIC

Contact Address: Workneh Ayalew, International Livestock Research Institute (ILRI), P O Box 5689, Addis Ababa, Ethiopia, e-mail: w.ayalew@cgiar.org

Phenotypic Characteristics of Four Indigenous Chicken Breeds in Cambodia

SANN VATHANA, SAMELL KEO

Royal University of Agriculture, Faculty of Animal Science and Veterinary Medicine, Cambodia

Domestic poultry diversity is an important part of food resource, especially among rural farmers in Cambodia. However, the pressure on its production system is increasing rapidly. Chicken diversity can be exploited by characterising its performance and farmer acceptance. This paper aimed to describe the phenotypic characteristics of four major indigenous chicken breeds in Cambodia. Surveys were carried out during 2003–2004 as fact finding study to investigate the major breed candidates. Seven candidates were recorded from 150 sampled households, however, only 4 breeds were frequently observed. Sampov (Local bantam: A), accounted for 55 % of total population, whereas Kandong (Slow feathering: B), Skoeuy (Bicolour: C), and Kragnas (Frizzle: D) represented 10, 7, and 5 % respectively. Except A which was found thoroughly, each breed had regional-specific location. Secondly, an on-station experiment to determine the growth performance of these four breeds was conducted with seven week old chickens for 12 weeks. The average daily gain (g/day) of A (15.74) and B (15.31) were significantly higher than C (13.35) and higher than D (12.05). Breeds showed differences in their feather feature, colour, and length. Male A showed a bright colourful red and black feather whereas barbules colour was typical in C. Male B had less dorsal and body feather than any other breeds. The dominant colour in D was pale black and their contour feathers are curved outward. The comparative percentage of feather of A was 8.92 significantly higher than C (5.70) and C (4.78) and higher than B (3.83) resulted in differences in percentage of plucked and dressed weighs. Phenotypic characteristic of these breeds is concreted information while available documentation is still limited. Ranking the economical value of these breeds is not necessary while farmers have different acceptant criteria. It is required more investigation on on-farm performance of these breeds and their tolerance to epidemic disease. The most rational and sustainable way to conserve these resources to combat threat to rural food security is to ensure that indigenous breeds remain functional parts of production systems.

Keywords: Genetic diversity, indigenous chicken, promising economic breed

Contact Address: Sann Vathana, Royal University of Agriculture, Faculty of Animal Science and Veterinary Medicine, Phnom Penh, Cambodia, e-mail: vathana20@yahoo.com

Molecular Characterisation and Chromosomal Assignment of Porcine Bax and Tac1

WATCHARA LAENOI[1,2], CHRISTOPH KNORR[2,1], RANGSAN CHAROENSOOK[1], KESINEE GATPHAYAK[1], THERDCHAI VEARASILP[1], UDO TER MEULEN[3], BERTRAM BRENIG[2]

[1]*Chiangmai University, Department of Animal Science, Thailand*

[2]*Georg-August-University Göttingen, Institute of Veterinary Medicine, Germany*

[3]*Georg-August-University Goettingen, Institute of Animal Physiology and Animal Nutrition, Germany*

The BCL^{-2} associated X protein (BAX) is a member of the Bcl^{-2} protein family and functions as a repressor of programmed cell death (apoptosis). The preprotachykinin A gene (TAC1) encodes two tachykinin peptides (substance P and neurokinin A) that act as neurotransmitters in the central and peripheral nervous systems. To isolate the genes from the porcine genomic PAC library TAIGP714 probes were generated with primers derived from exons of the human orthologs. For Bax, a 501-bp long fragment (spanning exons 3 to 4) was amplified on porcine genomic DNA (GenBank Accession no: AM233489). The TAC1-specific primers formed a 415-bp long amplicon (spanning exon 7) in pigs (GenBank Accession no: AM233488). Probe sequencing and comparison with the human genes verified sequence identity (BAX 94 % and TAC1 84 %). The gene-containing PAC clones were further isolated and sequenced. The chromosomal assignment of the genes was done by analyses of porcine hybrid panels (somatic cell and radiation hybrid panel) and by fluorescent *in situ* hybridisation. BAX was assigned to SSC6q21 and TAC1 to SSC9q12-q14. So far, comparative exon sequencing using a panel of 138 animals (Angeln Saddleback, Pietrain, German Landrace, German Edelschwein, Swabian-Haellian swine, Buntes Bentheimer, Thai native pigs, Thai wild pig, Chinese Luchuan, Chinese Rongchang, Chinese Yushanei as well as German and Thai herniated crossbred piglets) identified two SNPs in BAX (SNPintron1: C→T, p(C)=0.804 and q(T)=0.196; SNPintron3: T→A, p(T)=0.975 and q(A)=0.025). Up to now, no SNPs have been found in TAC1. The chromosomal localisation of BAX in combination with its known physiology proposes a possible contribution of the gene to the phenotype hernia, but this hypothesis has to be further elucidated.

Keywords: BAX, pig, SSC6q21, SSC9q12–14, TAC1

Contact Address: Christoph Knorr, Georg-August-University Göttingen, Institute of Veterinary Medicine, Burckhardtweg 2, 37077 Göttingen, Germany, e-mail: cknorr@gwdg.de

Marker Assisted Selection for Disease Resistance in Nucleus Breeding Systems from a Crossbreeding Experiment — a Simulation Study

ULRIKE JANSSEN-TAPKEN, HAJA N. KADARMIDEEN, PETER VON ROHR
Swiss Federal Institute of Technology Zurich (ETH), Institute of Animal Sciences, Switzerland

The aim of the study was to evaluate different breeding strategies for disease resistance in combination with production traits in pastoral systems with experimental data for genetic information and results from questionnaires for socio-economic aspects. Using a stochastic approach, a closed nucleus breeding was simulated. The base population consisted of N = 400 unrelated F2 crossbreed individuals from two breeds with fixed alleles in the desired traits: decrease in packed red blood cell volume (PCVD), decrease in body weight (BWD), natural logarithm of the mean count of parasites (PAR) as indicator of Trypanotolerance, live weight at 12 months of age (LW), milk yield (MY) and calving interval (CI) for production and reproduction traits. There were 10 discrete generations of selection; with selected animals in each generation randomly mated with the assumption of AI and MOET. The genotype of each individual was modeled using 10 unlinked additive quantitative trait loci (QTL) with two flanking markers each and a model with 100 loci without marker information for the polygenic effect. The phenotypic values were sum of genotypic and a residual effect. The input parameters for QTL and marker as well as LW variance and correlations were taken from results of the completed QTL mapping experiments by the International Livestock Research Institute (ILRI) in Kenya; other information for the remaining traits was based on international studies. The economic values came from a socio-economic study in pastoral production systems. Breeding value estimation for selection was based on best linear unbiased prediction (BLUP), BLUP in combination with marker information (MABLUP) and estimation on markers only (MA). Results indicate greater genetic gain via BLUP-evaluation but also reasonable genetic gain via MABLUP with better results for disease resistance. MA-results require more computational time but show the potential genetic gain without infecting the animals for phenotypic observations.

Keywords: Cattle breeding, disease resistance, marker assisted selection, nucleus breeding system, simulation, stochastic approach

Contact Address: Ulrike Janßen-Tapken, Swiss Federal Institute of Technology Zurich (ETH), Institute of Animal Sciences, ETH Zentrum UNS, Universitätsstrasse 65, 8092 Zürich, Switzerland, e-mail: ulrike.janssen@inw.agrl.ethz.ch

Genetic Analysis of Bovine Embryonic Biopsies as a Tool to Identify Genes Related to the Establishment of Pregnancy after Embryo Transfer

ASHRAF EL-SAYED[1], MICHAEL HOELKER[1], FRANCA RINGS[1], DANYEL JENNEN[1], ERNST THOELN[1], MARC-ANDRÉ SIRARD[2], KARL SCHELLANDER[1], DAWIT TESFAYE[1]

[1] *University of Bonn, Institute of Animal Science, Animal Breeding and Husbandry Group, Germany*

[2] *University of Laval, Research Center for Reproduction Biology, Department of Animal Sciences, Canada*

The purpose of this work is to address the relationship between transcriptional profile of embryos and the pregnancy success based on blastocyst biopsies taken prior to transfer to recipients. Biopsies (30–40 % of the intact embryo) were taken from IVP day 7 blastocysts (n=98) and 60–70 % part were transferred to recipients after re-expansion. Based on the success of pregnancy, biopsies were pooled in three groups: those resulted in no pregnancy (G1), resorption (G2) and those resulted in calf delivery (G3). Gene expression analysis of these groups of biopsies was performed using home made bovine preimplantation specific array (219 clones) and cDNA array (BlueChip) (2000 clones). Three independent pools (10 in each) of biopsies from the three groups were used for mRNA isolation and subsequent RNA amplification. Approximately 2 μg of amplified RNA was used from each group to perform an indirect dye labelling. Images were analysed using GenePix Pro Version 4.0 software. Data analysis performed using Significant Analysis for Microarray (SAM) software. Real-time PCR was used to confirm the resut of microarray experiments. A total of 52 genes were differentially regulated between G1 and G3 and 58 genes differentially regulated between G2 and G3. Biopsies resulted in calf delivery are enriched with genes necessary for implantation like (Cox2 and Cdx2), carbohydrate metabolism (ALOX15), growth factor (BMP15), signal transduction (PLAU) and placenta-specific 8 (PLAC8). Biopsies from blastocyst ended with resorption are enriched with transcripts involved protein phosphorylation (Cytokeratin A) Plasma membrane (Occludin) and glucose metabolism (PGK and aldose reductase). Biopsies from blastocyst resulted in no pregnancy are enriched with transcripts involved inflammatory cytokines (TNF1a), protein amino acid binding (EEF1A1), transcription factors (MSX1 and PTTG1), glucose metabolism (PGK, aldose reductase) and CD9 which is inhibitor of implantation. In conclusion, we generated direct candidates of blastocyst specific genes which determine the fate of the embryo after transfer.

Keywords: Blastocyst, cattle, embryo loss, microarray, preimplantation

Contact Address: Dawit Tesfaye, University of Bonn, Institute of Animal Science, Animal Breeding and Husbandry Group, Endenicher Allee 15, 53115 Bonn, Germany, e-mail: tesfaye@itz.uni-bonn.de

The Bovine Oviduct as a Temporary in Vivo Culture System for Oocytes and Embryos Derived from in Vitro Production

MICHAEL HOELKER[1], URBAN BESENFELDER[2], VITA HAVLICEK[1], FRANCA RINGS[1], DAWIT TESFAYE[1], DANYEL JENNEN[1], KARL SCHELLANDER[1]

[1]*University of Bonn, Institute of Animal Science, Animal Breeding and Husbandry Group, Germany*

[2]*University of Veterinary Sciences, Institute of Animal Breeding and Genetics, Austria*

In vitro production (IVP) of bovine embryos offers enormous potential both for agriculture and animal breeding. However, its widespread use is still fraught with problems, since in vitro produced embryos do not reach the quality of in vivo derived embryos. Thereby the aim of the present work was to explore whether a temporary culture in the bovine oviduct enhances the quantity and quality in vitro produced embryos. A total of 758 in vitro produced embryos at 8-cell stage were endoscopically transferred to the oviduct of 15 synchronised recipient heifers (43–59 per recipient) and were flushed back at day 7. As a control we produced 547 embryos parallel and cultured them until day 7 completely in vitro (CR1, 5 % CO_2, 20 % O_2). In a second experiment we incubated 646 cumulus oocyte complexes together with frozen-thawed spermatozoa and transferred both into the fallopian tube of the oviducts of 12 synchronised recipient heifers (50–77 cumulus oocyte complexes per recipient) and flushed embryos back at day 7. As a control we cultured 441 cumulus oocyte complexes which had been incubated with spermatozoa parallel to the transferred cumulus oocytes complexes completely in vitro. Embryos transferred into the ovicuct at 8-cell stage did not reach higher blastocyst rates at day 7 than completely in vitro cultured embryos (23.7 % vs. 24.7 %). Contrary, cumulus oocyte complexes transferred together with spermatozoa into the bovine oviduct at day 0 reached significant higher blastocyst rates ($p < 0.05$) at day 7 (16.31 % vs. 6.89 %), day 8 (28.34 % vs. 19.72 %) and day 9 (31.1 % vs. 24.31 %) than completely in vitro cultured complexes. Moreover, blastocyst development (day 7/day 9) was faster in the in vivo cultured embryos (52.5 % vs. 33.6 %). Collectively, we were able to show that in vivo culture from fertilisation up to day 7 can enhance embryonic preimplantative development while in vivo culture from 8-cell to day 7 stage does not. That suggests that microenvironment in the period from fertilisation up to 8-cell stage has superior impact on bovine embryo development in terms of blastocyst quantity and quality than culture condition after 8-cell stage.

Keywords: Bovine, embryo transfer, in vitro, in vivo, oviduct

Contact Address: Michael Hoelker, University of Bonn, Institute of Animal Science, Animal Breeding and Husbandry Group, Endenicher Allee 15, 53115 Bonn, Germany, e-mail: michael.hoelker@itz.uni-bonn.de

Expression of Apoptosis Regulatory Genes and Incidence of Apoptosis in Different Morphological Quality Groups of Ivp Bovine Preimplantation Embryos

MELKAYE GEBRESELASSIE MELKA[1], DAWIT TESFAYE[1], KARL SCHELLANDER[1], FRANCA RINGS[1], MICHAEL HOELKER[1], VITA HAVLICEK[1], URBAN BESENFELDER[2]

[1] *University of Bonn, Institute of Animal Science, Animal Breeding and Husbandry Group, Germany*

[2] *University of Veterinary Sciences, Institute of Animal Breeding and Genetics, Austria*

Apoptosis occurs during early development in both in vivo- and vitro- produced embryos, and may cause embryonic loss. In order to resolve the mechanisms and reasons of cellular fragmentation it is crucial to understand what genes may be responsible for regulation of this process. Despite the fact that apoptosis plays an important role in preimplantation embryo development, the correlation among morpholocial embryo quality, expression of apoptosis regulatory genes and the incidence of apoptosis has not yet been established. The objectives of this study were, therefore, investigating stage specific mRNA and protein expression profiles of apoptosis regulatory genes in three quality groups of in vitro-produced bovine preimplantation embryos; analysing the relationship between DNA fragmentation and morphological quality of embryos; and investigating the mRNA expression of Ped gene in bovine embryos of different cleavage rates. The relative abundance of mRNA of 9 pro- (Bax, caspase-9, Bcl-xs, P53, caspase^{-3}, Fas) and anti- (Bcl-w, Bcl^{-2} and Mcl^{-1}) apoptotic genes was analysed by using real time PCR. Moreover, differential cell staining, TUNEL labelling and western blot were done to analyse the variation in cell numbers, detect apoptotic nuclei and protein expression, respectively. The expression of Bax, caspase^{-3} and caspase-9 genes was found to be significantly ($p < 0.05$) higher in poor quality preimplantation embryos as compared with that of morphologically good embryos of the same stage of development. Moreover, the anti-apoptosis Mcl^{-1} expression was significantly higher in good quality groups of immature oocytes, 8-cell and Morula stage embryos than that of their poor quality counterparts. Bax protein was detected only in morphologically poor quality blastocysts. Bcl^{-2} protein was not detected in quality 1, 2, & 3 blastocysts. In conclusion, a higher incidence of apoptosis was evidenced in morphologically poor quality blastocysts and this study demonstrates that Bax, caspase^{-3} and Mcl^{-1} can be used as potential markers of embryo quality to evaluate in vitro produced bovine preimplantation embryos.

Keywords: Apoptosis, bovine embryo, embryo quality

Contact Address: Melkaye Gebreselassie Melka, University of Bonn, Institute of Animal Science, Animal Breeding and Husbandry Group, Endenicher Allee 17, Bonn, Germany, e-mail: melke_g@yahoo.com

Dielectrophoretic Behaviour of MII Bovine Oocytes and Zygotes and its Relation to the Embryonic Developmental Competence and mRNA Expression Pattern

DESSIE SALILEW WONDIM, DAWIT TESFAYE, KARL SCHELLANDER

University of Bonn, Institute of Animal Science, Animal Breeding and Husbandry Group, Germany

This study was aimed at investigating the dielectrophoretic behaviour of oocytes and zygotes in relation to the developmental competence and transcriptional abundance. Metaphase II (MII) bovine oocytes with (PB+) and without (PB-) first polar body and zygotes were subjected to dielectrophoresis procedure designed as 4 MHz AC, 5 v, 450 μm electrode distance and medium conductivity 80 μs/cm. The PB+, PB- and zygotes were classified into very fast, fast, slow and very slow depending on their speed in the electric field. Parthenogenetic activation was used to assess the rate of embryonic development of dielectrophoretically separated of oocytes. The result shows that,in PB+ oocytes the blastocyst rate at 7 (days post activation) dpa was higher ($p < 0.05$) in very fast than in very slow. In PB- oocytes, the blastocyst rate at 6 and 7 dpa was higher ($p < 0.05$) in the very fast and fast compared to the slow and very slow. Similarly, the total blastocyst rate at 7 days post insemination was higher ($p < 0.05$) in the very fast compared to very slow and slow dielectrophoretic categories of zygotes. Moreover, cDNA microarray experiments were performed between very fast and very slow dielectrophoretic PB+ oocytes and zygotes for transcriptional analysis. The result reveals that 31 and 5 genes were up and down regulated respectively in very fast compared to the very slow dielectrophoretic categories of oocytes. Among the up-regulated genes, DNMT1 and ANXA2 are believed to involve in ion binding. RPLP2 and RPLPO involve in protein biosynthesis and RNA binding. Others including NUSAP1 and CDC91L1 are involving in cell cycle regulation. Similarly, 25 and 17 genes were up and down regulated respectively in the very fast dielectrophoretic categories of zygotes relative to the very slow. Among the up-regulated genes, NANOS1, ZNF85 and IQGAP1 are involved in ion binding and STK6, SMARCA5 and NASP are needed for cell cycle regulation. In conclusion dielectrophoretic separated oocytes and zygotes showed difference in the rate blastocyst development accompanied by difference in transcriptional abundances.

Keywords: Developmental rate , dielectrophoresis, oocyte, zygote

Contact Address: Dessie Salilew Wondim, University of Bonn, Institute of Animal Science, Animal Breeding and Husbandry Group, Endenicher Allee 15, Bonn, Germany, e-mail: dsalilew@uni-bonn.de

Muscle Fiber Type Distribution of Longissimus Dorsi Muscle in High and Low Performing Pigs and in Different Pig Breeds

NGUYEN TRONG NGU[1], DANYEL JENNEN[1], SIRILUCK PONSUKSILI[2], EDUARD MURANI[2], DAWIT TESFAYE[1], KARL SCHELLANDER[1], KLAUS WIMMERS[2]

[1] *University of Bonn, Institute of Animal Science, Animal Breeding and Husbandry Group, Germany*

[2] *Research Institute for the Biology of Farm Animals (FBN), Germany*

Muscle fiber types, characterised by the content of different myosin heavy chain (MYH) isoforms, are responsible for variation of growth performance and meat quality traits in farm animals. The first objective of this study was to compare the muscle fiber type composition based on relative abundance of transcripts of MYH isoforms in animals showing high and low muscularity within breed. For this experiment, six discordant sibpairs representing extremes for the complex trait body conformation were selected from a F2 resource population DUMI, which was created by reciprocal crossbreeding of Duroc and Berlin Miniature pigs, a cross of Vietnamese Pot Belly Pigs, Saddle Back Pigs and German Landrace. Secondly, we aimed to compare the expression profile of MYH isoforms among different breeds of Duroc and Pietrain from Germany and Mongcai from Vietnam, which have been known to extremely differ in muscle growth and meat quality. Results from real-time RT-PCR quantification of MYH isoform I, IIa, IIx and IIb showed that the relative expression of MYH IIb (fast-glycolytic) was significantly higher ($p < 0.05$) in pigs with large muscle area in DUMI (60.5 vs 47.5 %). Conversely, the content of MYH I/slow (slow-oxidative) fibers was statistically different ($p < 0.05$) with lower percentage in high performing animals (18.4 vs 33.5 %). Moreover, the comparison among breeds confirmed the trend of high MYH IIb transcript abundance going together with high muscularity. In Pietrain and Duroc, abundance of MYH IIb accounted for more than half of the MYH transcripts (65.4 % and 59.7 %) whereas Mongcai showed very low MYH IIb (11.4 %) but high type I, IIa and IIx RNA levels (24.1, 28.5 and 35.9 %, respectively). All together, the present results indicate that IIb fibers are the most prominent in pigs having large eye muscle area. (This project was supported by the Federal Ministry of Education and Research, BMBF grant VNB02/B06, Germany).

Keywords: Different pig breeds, muscle fiber, myosin heavy chain, realtime RT-PCR

Contact Address: Klaus Wimmers, Research Institute for the Biology of Farm Animals (FBN), Germany, Research Unit of Molecular Biology, 18196 Dummerstorf, Germany, e-mail: wimmers@fbn-dummerstorf.de

Animal Nutrition: Ruminants

Preliminary Report on Nutritive Value of Tree Foliages Available In yezin Area, Myanmar

NI NI MAW, AUNG AUNG, KHIN SAN MU
University of Veterinary Science, Myanmar

Tree leaves are considered to be the most abundant protein source in nature. These form a bulk of ruminant diets in tropical, arid and semi-arid, and hilly regions. Conventionally, tree foliages have been fed together with gricultural by-products, mainly crop residues, containing low levels of nitrogen to nhance rumen microbial fermentation and hence the animal productivity. In Myanmar, the use of tree leaves has received little attention in the feeding systems for ruminants, mainly because of inadequate knowledge on their nutritive value. We have undertaken studies to:

- evaluate the nutritive values of locally available tree foliages,
- conduct feeding trials and assess the feeding value of tree foliages in large
- evaluate the nutritive values of locally available tree foliages,
- conduct feeding trials and assess the feeding value of tree foliages in large and small ruminants,
- examine the usage of tree foliages as replacement of commercial concentrates,
- introduce tree foliages as protein supplements in Urea Molasses Multinutrient Blocks (UMMB), and
- transfer feeding strategies to farmers in the region.

This paper reports our preliminary findings on some nutritive value parameters. Proximate analyses of leaves from 30 species of trees were carried out from October 2001 to March 2002. The values of DM (8.3–86.5 %), OM (66.89–98.05 %),CP (8.03–32.43 %), neutral detergent fibre (16.93–71.10 %), and acid detergent fibre (7.37–53.10 %), respectively. These results suggest that some of tree leaves, (e.g., *Fluggea leucopyru*, *Leucaena leucocephala* and *Gliricidia sepium*, with CP levels 28.78 %, 22.0 %, 18.64 % respectively) could be good sources of protein for ruminants. Dried L. leucocepahala leaves have been incorporated in the UMMB at 8 % level. Acceptability and intakestudies on these blocks and their response on dairy cows in Yezin area are being investigated.

Keywords: Nutritive values, tree foliages

Contact Address: Ni Ni Maw, University of Veterinary Science, U.v.sc, Yezin, Myanmar, e-mail: ninimaw05@gmail.com

Influences of Cutting Age and Ensilage Method on Yield Chemical Compositions and Ruminal Dry Matter and Organic Matter Degradability of Suwan 1 and Suwan 5 Corn (Zea May Linn)

O. INSUNG

Rajamangala University of Technology Srivijaya, Nakhonsithammarat Campus, Thailand

The research was conducted to investigate the influences of the cutting ages and the ensilage methods on yield, chemical compositions and ruminal dry matter and organic matter degradability of Suwan1 and Suwan5 corn. It was found that only the height and the stem diameter which were different across varieties ($p < 0.01$). Cutting plants at different cutting ages affected the heights of stems, stem diameters, total weights, stem and leaf weights ($p < 0.01$) and corncob weights ($p < 0.05$). The second experiment dealed with the influences of the cutting ages and ensilage methods on the chemical compositions and the quality of the ensiled plants. It was found that the cutting ages affected on the acid detergent fiber (ADF) ($p < 0.05$) only, but had no influences to neutral detergent fiber (NDF) ($p > 0.05$) and to acid detergent lignin ($p > 0.05$). The third trial was coped with the ruminal dry matter and organic matter degradability of ensiled corn samples using the nylon bag technique. It was found that all ruminal degradation parameters were not affected by the varieties of corn. The 'a', 'b', 'c', 'ed2', and the 'PTDG' values for the dry matter degradation were affected by the cutting ages ($p < 0.01$). The ensiled method affected the 'a', 'b', 'ed2' values ($p < 0.01$) but not the 'c', 'PTDG' and the lag time ($p > 0.05$). The degradation parameters of the organic matter were different from those of the dry matter for plant species, cutting age and for ensilage methods. The research result implies that the yield, quality and the ruminal degradability of Suwan1 were not much less than Suwan5 under this experiment environment.

Keywords: Chemical composition, corn, cutting age, ensilage method, ruminal degradability

Contact Address: O. Insung, Rajamangala University of Technology Srivijaya, Nakhonsithammarat Campus, Thungsong, 80110 Nakhonsithammarat, Thailand, e-mail: ongarge@lycos.com

Reduction of Poverty through Improved Animal Nutrition via Low Input Agricultural Production of *Panicum maximum*

OLAJIRE FAGBOLA[1], JACOB O BABAYEMI[2]

[1]*University of Ibadan, Department of Agronomy, Nigeria*

[2]*University of Ibadan, Animal Science, Nigeria*

Intensive grass production is yet to attract attention of farmers in the sub-saharan Africa. Hence, animals are poorly nourished via nutrient deficient forage since many tropical soils are low in nutrient content. The problem is further compounded through non-availability of chemical fertilisers coupled with poor logistics. Therefore, there is an urgent need for alternatives if animals will not be undernourished.

In a split-split-plot design experiment with three replicates under field conditions, the yield and nutrient content of *Panicum maximum* (var. Ntchisi) was evaluated. The main plot factor was arbuscular mycorrhizal (AM) fungi inoculation with two levels; inoculated and non-inoculated. The sub-plot factor was organomineral fertiliser (OM) application with four levels; grade A, grade B, mixtures of grades A and B and no feertilizer application. The sub-sub-plot factor was cutting frequencies (4, 6 and 8 weeks). Harvested forage was evaluated for yield, rumen degradability and nutrient composition. Data were analysed with ANOVA and the means separated using Duncan's multiple range test. Dry matter yields among fertiliser treated forages were similar but significantly higher compared to the control (no fertiliser application). Maximum dry matter yield, 11.04 t/ha was obtained under the application of the mixtures of organomineral fertilisers grades A and B. Grass inoculated with AM was 15.8 % higher in yield compared to non-inoculated. There was no effect of time of cutting on the dry matter yield of all treatments, but the yield increased with increasing cutting frequency. Application of OM and AM fungi enhanced the crude protein (CP) of the forage but have no significant effect on rumen dry matter degradation characteristics. The highest CP, 13.13 % was obtained when grass was inoculated with AM and had the mixtures of fertilisers applied. Cutting frequency significantly affected the dry matter and CP release. With increasing cutting frequency, the degradation features of the forage increased. Quantitative and qualitative production of nutrient enriched grass for ruminants through the combinations of the assayed agronomic practices is possible.

Keywords: Rumen: grass: fertiliser: degradability: crude protein: yield

Contact Address: Olajire Fagbola, University of Ibadan, Department of Agronomy, Ibadan, Nigeria, e-mail: fagbola8@yahoo.co.uk

Investigation on the Effects of Supplementation of Chickpea Husk and Boiled Sesame Meal on the Performance of Growing Bulls in Myanmar

AUNG AUNG, KHIN SAN MU, MAR MAR KYI, MOE THIDA HTUN, TIN NGWE, NI NI MAW

University of Veterinary Science, Department of Physiology and Biochemistry, Myanmar

Four growing bulls in Yezin area in were randomly allotted to a 2×2 factorial arrangement in a 4×4 Latin square design to compare the effectiveness of four diets. Four dietary treatments were RUSC1 (Urea-treated rice straw + Untreated sesame meal + chickpea husk at the level of 0.1 % of liveweight), RBSC1 (Urea-treated rice straw + boiled sesame meal + chickpea husk at the level of 0.1 % of liveweight), RUSC2 (Urea-treated rice straw + untreated sesame meal + chickpea husk at the level of 0.2 % of liveweight) and RBSC2 (Urea-treated rice straw + boiled sesame meal + chickpea husk at the level of 0.2 % of liveweight). All dietary treatments were weekly adjusted by supplements at the level of crude protein not less than 10 %. Each feeding trial consisted of 15 days of adaptation, 7 days of preliminary feeding, 16 days of determination of voluntary intake for urea-treated rice straw and 3 days of faecal and urine collection. TDN intake (83.62 g/kg0.75 / day) for RUSC1 was satisfactory in comparison with other treatments, although the significant difference ($p < 0.05$) was not observed. Achievements for RBSC1 (63.28, 68.66, 83.18, and 73.75 %) were relatively higher than those of RUSC 2, RBSC2 and RBSC2. Slight differences in daily weight gain (0.82, 0.67, 0.51 and 0.64) were observed among the treatment means and that of RUSC1 was umerically satisfied. These parameters observed in this experiment showed that feed efficiency and weight gain of RUSC1 was numerically characteristic although is not significantly ($p < 0.05$) higher than those of other dietary treatments.

Keywords: Bolied sesame meal, chickpea husk, growing bulls

Contact Address: Aung Aung, University of Veterinary Science, Department of Physiology and Biochemistry, UVSc, Yezin, Myanmar, e-mail: aung.aaung@gmail.com

Control of *Leucaena toxicosis* in Myanmar Sheep Using IBT-Göttinger Bioreactor Grown Mimosine Degrading Ruminal *Klebsiella*

AUNG AUNG[1], HELGE BÖHNEL[2], TIN NGWE[1], UDO TER MEULEN[3]

[1]*University of Veterinary Science, Department of Physiology and Biochemistry, Myanmar*

[2]*Georg-August-University Göttingen, Institute of Tropical Animal Health, Germany*

[3]*Georg-August-University Goettingen, Institute of Animal Physiology and Animal Nutrition, Germany*

Rumen juice of German steer was taken and then treated with mimosine using a fermenter for 16 days to develop mimosine degrading bacteria. After this treatment, mimosine degrading bacteria (*Klebsiella spp*) were developed, then isolated and multiplied by using IBT-Göttinger Bioreactor. For the use of field experiment, they were incorporated with sodium alginic acid.

12 local sheep from Pyawbwe area, Myanmar, were allocated in 4 groups. The experiment was conducted with complete randomised design. Group I was fed with normal ration and used for control. Group II was used as treated control group fed with 40 % *Leucaena* of total ration and without inoculating with ruminal *Klebsiella*. Animals from group III and IV were fed with the same ration to group II. The microbes were inoculated to animals from group III once at the beginning of feeding trial and 14 days to animals from group IV continuously. Clinical sings, feed intake and body temperature were recorded daily. Experimental period was 14 days for feeding trial and 5 days for collection of faecal and urine samples.

Clinical signs of *Leucaena toxicosis* such as loss of hair and dullness were found in group II, but not in other treated groups. Daily intakes of animals from group II gradually decreased although it was increased in other groups. Body temperatures of treated control animals were also higher than others and ranged from 39.7 to 40.6 °C while the others at the range of 38 to 38.9 °C. The mean value of TDN intake (g/ d/ kg BW0.75) of group II (0.5) is significantly lower than those of group I (0.89), III (0.79) and IV (0.8) respectively.

According to these findings, IBT-Göttinger Bioreactor grown ruminal *Klebsiella* shows in vivo degradation of mimosine in Myanmar sheep.

Keywords: IBT-Goettinger Bioreactor, Kelbsiella, sheep

Contact Address: Aung Aung, University of Veterinary Science, Department of Physiology and Biochemistry, UVSc, Yezin, Myanmar, e-mail: aung.aaung@gmail.com

Cytotoxicity of *Haemophilus somnus* Grown in Continuous Culture

KAMAL ELDIN HASSAN ALI ELTOM, HELGE BÖHNEL, FRANK GESSLER
Georg-August-University Göttingen, Institute of Agronomy and Animal Production in the Tropics and Subtropics, Germany

Haemophilus somnus (*Histophilus somni*) is the cause of many disease manifestations in cattle and sheep including thrombotic meningoencephalitis (TME), pneumonia and reproductive disease. The effect of temperature and pH on the growth kinetics of *Haemophilus somnus* in continuous culture were investigated in a previous study. In this study, we present primary results of the investigation of the effects of temperature and pH on the cytotoxic activity of *Haemophilus somnus*. *Haemophilus somnus* 8025 (type strain) was grown in continuous culture system using the bioreactor (fermenter) of the Institute of Biotechnology in the Tropics (IBT), Göttingen, at each pH for 24 hours and at each temperature for 12 hours. The culture temperature was set at 37°C for studying the pH effect; for the temperature the pH was set at 7.1, while the culture agitation and dilution rates were kept constant. An MTT assay was used to determine the cytotoxicity of the cell free culture filtrate (CFCF) to MDCK cells. Fermenter cultures at different temperatures (29, 31, 33, 35, 37, 39 and 41°C) and pH (6.8, 7.0, 7.2, 7.4, 7.6, 7.8, 8 and 8.2) were tested. CFCF was 2-fold serially diluted in 96 well tissue culture plates. Non filtered Supernatant of some cultures was also tested for comparison. Controls of MDCK Cells, trypsin and fermenter medium were included in each plate. CFCF and supernatant of cultures at all pH and all temperatures tested, except at 29°C, were Cytotoxic to MDCK cells at the lower dilutions.

Keywords: Continuous culture, *Haemophilus somnus*, MTT assay

Contact Address: Kamal Eldin Hassan Ali Eltom, Georg-August-University Göttingen, Institute of Agronomy and Animal Production in the Tropics and Subtropics, Kellnerweg 6, 37077 Göttingen, Germany, e-mail: kamalhali@maktoob.com

Animal Nutrition: Chicken and Pigs

Effects of Salbutamol in Swine Diets on Quality and Salbutamol Residues in Pork after its Withdrawal of from the Diet for Seven Days before Slaught

SANCHAI JATURASITHA[1], PILASLUCK PANPRASERT[1], NUCHA SIMASATIKUL[1], RATCHANEEWAN KHIAOSA-ARD[1], THERDCHAI VEARASILP[1], MICHAEL KREUZER[2], PRASIT CHANARATHA[3]

[1]*Chiang Mai University, Department of Animal Science, Thailand*

[2]*ETH Zurich, Institute of Animal Science, Switzerland*

[3]*Chiang Mai University, Department of Clinical Microscopy, Thailand*

The objective of this investigation was to determine the effect of salbutamol supplementation for finishing swine which is sometimes illegally applied in Thailand to reduce carcass fatness. *Longissimus dorsi* muscles were obtained from crossbred swine (Duroc $\times$ (Large White $\times$ Landrace)) fed a diet containing 0 (control), 4, 8 and 12 ppm of salbutamol from 70–100 kg of live weight. Salbutamol was withdrawn from the diet 7 days before slaughter. Meat pH at 45 min and 24 hr p. m. was not different ($p > 0.05$) among groups. However, meat conductivity at 45 min p. m. was lower ($p < 0.05$) in all salbutamol treated groups than in control. Meat colour had a higher redness with salbutamol supplementation, and water holding capacity (WHC) was higher ($p < 0.05$) in the salbutamol-treated groups than in the control grou*p*. *S*wine fed diets with low salbutamol levels tended to have meat with high maximum shear force and energy ($p > 0.05$). *Longissimus dorsi* protein content was highest ($p < 0.05$) with 12 ppm salbutamol in the diet, and intramuscular fat content was lowest ($p < 0.05$) with 4 ppm salbutamol. No systematic variation with respect to salbutamol level was found with cholesterol and fat content of pork while shelf life as estimated by the thiobarbituric acid reactive substances (TBA) number, was prolonged with salbutamol ($p < 0.05$ with 12 vs 0 ppm salbutamol). Salbutamol residues in meat, liver and kidney clearly increased ($p < 0.05$) with increasing dietary level of salbutamol. In conclusion, the use of salbutamol has to be considered as a mal-practice in the tropics in the sense of a natural production systems approach.

Keywords: Beta-Agonist, Pork Quality, Residue, salbutamol

Contact Address: Sanchai Jaturasitha, Chiang Mai University, Department of Animal Science, 239 Heuy Kaew Rd., 50200 Chiang Mai, Thailand, e-mail: agisjtrs@chiangmai.ac.th

Study of Ileal Amino Acid Digestibility of Soybean and Sunflower Meals in Growing Pigs Using in Vivo and in Vitro Methods

KANYAKON WONGRAK[1], THERDCHAI VEARASILP[1], T. APICHARTSRUNGKOON[1], NUCHA SIMASATITKUL[1], WANDEE TARTRAKOON[2], UDO TER MEULEN[3]

[1]*Chiang Mai University, Animal Science, Thailand*

[2]*Naresuan University, Agricultural Science, Thailand*

[3]*Georg-August-University Goettingen, Institute of Animal Physiology and Animal Nutrition, Germany*

The objective of this study was to determine ileal crude protein and ileal amino acid digestibility of growing pig using in vivo and in vitro methods. The in vivo ileal digestibility was studied in first experiment using four crossbred barrows (Large White $\times$ Landrace $\times$ Duroc) at initial average weight of 40 kg BW. The animals were surgically fitted with ileal simple T shape cannula and housed in individual metabolism cage. The experimental diets were 1) broken rice-soybean meal 2) corn-soybean meal 3) cassava starch-soybean meal and 4) cassava starch-sunflower-soybean meals. The experimental work was 4×4 latin square design. The in vitro ileal digestibility was studied with the same experimental diets as in the first experiment but using intestinal digesta collected from the same experimental animals. The average value of in vivo ileal digestibility for protein of all treatments (broken rice-soybean meal and corn-soybean meal, cassava starch-soybean meal and cassava starch-sunflower-soybean meals diets) and all feedstuffs (broken rice, corn, soybean meal and sunflower meal) were lower ($p < 0.05$) than those of the in vitro method. Meanwhile, in vivo ileal digestibility of amino acids for all treatments and all feedstuffs were higher ($p < 0.05$) than those of the in vitro method. The correlation coefficient of ileal digestibility for lysine and crude protein between in vivo and in vitro methods were high (r=0.8000, 0.6682, respectively). The regression equations of lysine and crude protein were Y=71.6471+0.1445X and Y=70.4556+0.1296X respectively. While, the correlation coefficient of ileal digestibility for DM and arginine between in vivo and in vitro methods were lowest. There was no correlation coefficient of ileal digestibility for threonine, valine and isoleusine between in vivo and in vitro methods.

Keywords: Amino acid, correlation coefficient, crude protein, in vitro digestibility, in vivo digestibility

Contact Address: Therdchai Vearasilp, Chiang Mai University, Department of Animal Science, 239 Huay Kaew Road, 50200 Chiang Mai, Thailand, e-mail: agitvrsl@chiangmai.ac.th

The Effect of Inclusion of Dietary Tuna Oil in Diets of Growing-finishing Pigs on Slaughter Weight and Backfat Characteristics

SANCHAI JATURASITHA[1], TIRANUN SRIKANCHAI[2], MICHAEL WICKE[3], VIBOON RATTANAPANON[4], SEBASTIAN CHAKEREDZA[5], UDO TER MEULEN[5]

[1]*Chiang Mai University, Department of Animal Science, Thailand*

[2]*Research Institute for the Biology of Farm Animal, Germany*

[3]*University of Goettingen, Inst. of Animal Breeding and Husbandry, Germany*

[4]*Chiang Mai University, Department of Biochemistry, Thailand*

[5]*Georg-August-University Göttingen, Institute for Animal Physiology and Animal Nutrition, Germany*

This study was evaluated the effect of inclusion of tuna oil in diets of growing-finishing pigs (barrows and gilts) on backfat characteristics when slaughtered at different weights. Four hundred and eighty crossbred pigs averaging 30 kg were assigned to 12 treatment combinations (40 pigs/treatment combination) in a $2 \times 2 \times 3$ factorial arrangement. The treatments were: dietary (0 and 2 % tuna oil); sex (barrows and gilts); and slaughter weight (90, 100 and 110 kg). As pigs reached their slaughter weight, they were randomly selected (8 pigs/treatment combination; 96 pigs in total) and slaughtered. Backfat colour, hardness, melting point and fatty acid profile were assessed. There was no significant difference in colour among treatments. Backfat of tuna oil group and of gilts was softer than those of the control group ($p < 0.001$) and barrows ($p < 0.05$), respectively. This could have resulted in the low melting point of fat. Moreover, the thiobarbituric acid reactive substances (TBA) values of fat from tuna oil group stored for 3 days was higher ($p < 0.001$) than that of the control group. The cholesterol and triglyceride levels were not affected by diet and sex but the triglyceride level increased with increasing slaughter weight ($p < 0.01$). The tuna oil group had higher polyunsaturated fatty acid (PUFA) content, ratio of PUFA: saturated fatty acid (SFA) and total n^{-3} fatty acids but lower n6:n3 fatty acid than those of the control group ($p < 0.01$). Gilts had higher PUFA in backfat than barrows ($p < 0.05$). The backfat from both 90 and 100 kg slaughter weight had a lower ratio of n6:n3 fatty acid than that of 110 kg group ($p < 0.05$). Therefore, feeding growing-finishing swine with 2 % tuna oil increases omega^{-3} fatty acid in backfat. The PUFA:SFA was increased and n6:n3 ratios approached the recommended levels for healthy eating in human beings. However, due to oxidative susceptibility barrows should not be slaughtered at more than 100 kg to be acceptable to consumers.

Keywords: Backfat, fatty acid, pig, tuna oil

Contact Address: Sanchai Jaturasitha, Chiang Mai University, Department of Animal Science, 239 Heuy Kaew Rd., 50200 Chiang Mai, Thailand, e-mail: agisjtrs@chiangmai.ac.th

Chemical Composition and Sensory Evaluation of Breast Muscle of Indigenous and Modern Chickens Raised in North Thailand

SANCHAI JATURASITHA[1], PARINYA KANYAKUM[1], RATCHANEEWAN KHIAOSA-ARD[1], NUCHA SIMASATITKUL[1], MICHAEL WICKE[2], AMNUAY LEAWTHARAKUL[3]

[1]*Chiang Mai University, Department of Animal Science, Thailand*

[2]*University of Goettingen, Inst. of Animal Breeding and Husbandry, Germany*

[3]*Chiang Mai Livestock Research and Breeding, Thailand*

The experiment was conducted to determine chemical composition and sensory evaluation of breast muscle of four different chicken strains, namely, Bresse, Maehongson, and black-boned chickens (Cheefah and Faluang). Maehongson, Cheefah and Fahluang chickens are indigenous chickens raised in the rural mountainous area of Maehongson province, North Thailand. Maehongson chicken originated from wild chicken that has been trapped to raise at home in order to improve the behaviour. Cheefah and Fahluang are black-boned chickens raised by hilltribe people at Maehongson province as well. They have meat, skin, bone and even internal organ in black colour. The Bresse strain originates from the south of Burgundy County (France) and has been introduced to Thailand as it is also considered to have a comparably dark meat. Eighty chickens of each strain were equally separated into male and female. Using a 4×2 factorial arrangement, the experiment was designed in CRD. The chickens were raised from one day to 16 weeks of age. The result showed that Bresse chicken (modern strain) had higher fat percentage than indigenous strains ($p < 0.01$) but the protein percentage, it found no significant difference among strains. Breast muscle of Maehongson strain (native chicken) had higher cholesterol and triglyceride content as well as TBA number than other strains ($p < 0.01$). The sensory evaluation in term of tenderness, flavor and overall acceptability for all strains were not different. Bresse muscle had higher shear force value than other indigenous strains. Furthermore, black-boned chickens found to have mild quality among modern and native chickens. In conclusion, as the differences were minor in magnitude, indigenous strains have the potential to as a product for a niche market

Keywords: Breast, chemical composition, chicken, panel test

Contact Address: Sanchai Jaturasitha, Chiang Mai University, Department of Animal Science, 239 Heuy Kaew Rd., 50200 Chiang Mai, Thailand, e-mail: agisjtrs@chiangmai.ac.th

Utilisation of Velvet Bean (*Mucuna pruriens*) for Broiler Production in Nigeria

EUSTACE AYEMERE IYAYI, TOLULOPE OSOSANYA, OLUWAKEMI ADENIYI
University of Ibadan, Ibadan, Nigeria, Department of Animal Science, Nigeria

Velvet beans (*Mucuna pruriens*) is currently being promoted as food for man and feed for animals in Nigeria. Its implication and potential as alternative plant protein was studied with one hundred and eight 1-d-old broiler Anak chicks. Raw and heated *mucuna* bean meal (RMBM & HMBM, respectively) were used to replace soybean meal (SBM)and to assess the effect on performance and organs relative weights in the birds at both the starter and finisher phases. Three diets were formulated. Diet 1 was the basal diet and contained 120g kg^{-1} SBM while diets 2 and 3 contained 120 g kg^{-1} RMBM and HMBM, respectively in place of SBM. Each diet had 3 groups of 12 birds each. Feed intake, FCR and weight gain in birds on the RMBM and HMBM diets were significantly ($p < 0.05$) depressed compared to birds on the SBM diet at the starter phase but not at the finisher phase. The relative weights of liver, spleen, kidney, heart and brain were significantly ($p < 0.05$) reduced in the birds on the RMBM diet compared to those on the basal and HMBM diets. The packed cell volume (PCV), haemoglobin (Hb), red blood cell count (RBC) and white blood cells (WBC) were significantly ($p < 0.05$) reduced in the RMBM diets compared to the other 2 diets. Histopathological results showed that birds on the RMBM diet showed severe and widespread vacuolar degeneration and necrosis of the hepatocytes, interstitial congestion, tubular degenerations and necrosis in the kidneys. The hearts in birds on the RMBM diet had degeneration and fragmentation of their myofibrils and lymphoid depopulation in the spleen. These results suggest the possibility of utilising *mucuna* bean meal to replace soybean meal in broiler feeding at both starter and finisher phases. However, in spite of its present promotion as food for man and feed for animals in the country, the bean should be subjected to appropriate processing like dry heating to overcome its depressive effects on feed intake, growth and degenerative syndromes in organs.

Keywords: Broilers, mucuna bean, Nigeria , production

Contact Address: Eustace Ayemere Iyayi, University of Ibadan, Ibadan, Nigeria, Department of Animal Science, Ibadan, Nigeria, e-mail: eustace.iyayi@mail.ui.edu.ng

Effect of Dietary L-ascorbyl-2-phosphate magnesium on the Growth, Survival Rate and Stress Resistance of Juvenile Giant Freshwater Prawn (*Macrobrachium rosenbergii*)

YENNI NURAINI[1], M. AGUS SUPRAYUDI[2], STEPHAN WESSELS[1], GABRIELE HÖRSTGEN-SCHWARK[1]

[1]*Georg-August University, Göttingen, Institute of Animal Husbandry and Genetics, selected*

[2]*Bogor Agricultural University, Faculty of Fisheries and Marine Science, Indonesia*

Among other factors, suboptimal feed quality may contribute to low survival rates of juvenile giant freshwater prawn. Most fish and shrimps are extremely sensitive to vitamin C deficiency. Quantitative requirements of vitamin C for optimum prawn growth varies among species and size of prawns. Therefore the objective of this experiment was to detect the amount of L-ascorbyl-2-phosphate magnesium (L-APM) in the diet allowing optimum growth and survival. Experiments were carried out at the hatchery of the Bogor Extension Fisheries Programme, Bogor, Indonesia. Aquaria, each with a water volume of 65 litres, were stocked with 100 post larvae (PL) of 0.02 g average weight. After adaptation, post larvae were fed with pelleted test feed (1mm diameter, 3000 Kcal DE/kg) including five different levels of L-ascorbyl-2-phosphate magnesium (L-APM):0 (control), 50, 100, 150, and 200 mg/kg of feed. Each level of L-APM was tested in triplicate (18 aquaria). Juveniles were fed to satiation three times per day over a period of 60 days. The daily amount of feed ingested was recorded for each aquarium. After 60 days, PL were counted and weighted again. Water quality parameters (temperature, pH, oxygen, nitrite, ammonia) were measured daily during the whole experimental period. The best growth of juveniles was observed in the L-APM treatment with 200 mg/kg feed and the highest survival rates in the L-APM treatment with 150 and 200 mg/kg feed. The highest lipid retention (1.16 %) was observed in juveniles fed with L-APM supplement of 200 mg/kg of feed. Whereas the highest protein retention (2.48 %) was found in juveniles fed on a ration supplemented with a L-APM level of 150 mg/kg of feed. The optimum level of L-APM as a source of vitamin C for increasing survival rate was 150 mg L-APM/kg of feed. The results clearly showed that addition of L-APM to the diet can improve the growth and survival rate of the giant freshwater prawn juveniles.

Keywords: Growth rate, L-ascorbyl-2-phosphate magnesium, *Macrobrachium rosenbergii*, survival rate

Contact Address: Stephan Wessels, Georg-August-University Göttingen, Institute of Animal Husbandry and Genetics, Albrecht-Thaer-Weg 3, 37075 Göttingen, Germany, e-mail: swessel@gwdg.de

Endogenous Development by livestock keepers

Filling Knowledge Gap of Smallholder Cattle Keepers on Prevalence and Control of Bovine Trypanosomosis: an Example from Dano District, Western Ethiopia

SIMON RIEDEL[1,2], CLEMENS WOLLNY[2], TEMESGEN AYANA[3], WORKNEH AYALEW[2]

[1]*Georg-August-University Göttingen, Biotechnology, Germany*

[2]*International Livestock Research Institute, (ILRI), Ethiopia*

[3]*Bako Agricultural Research Centre, Animal Production, Ethiopia*

Trypanosomosis is a major constraint to cattle farmers in parts of Sub Saharan Africa, including Ethiopia. ILRI in collaboration with national partners in Benin, Kenya and Ethiopia is implementing a project on "Improving Livelihood of the poor through Community based Management of Indigenous Animal Genetic Resources". This project seeks to develop participatory processes in sustainable improvement of cattle production. In Ethiopia, the project works with smallholder cattle keepers in Dano District in the south-west of the country. Diseases, and particularly Trypanosomosis, were identified by farmers to be the most important constraint to cattle production, followed by seasonal scarcity of feed and water. As part of designing a development framework for sustainable utilization of lical cattle, this study explored the cattle keepers' knowledge on the prevalence and control of Trypanosomosis. Semi-structured interviews were used to document farmers' perception about the disease and their control measures. Laboratory diagnosis was used to record disease prevalence in cattle which were identified by farmers to sick with Trypanosomosis. The results showed that farmers are not aware of the nature of disease transmission, correct disease symptoms and their control measures. Blood examinations on 84 sample animals, suspected to be infected showed that 27.4 % of the cattle indeed were infected with Trypanosomosis. 83 animals were infected with *Trypanosoma congolense*, and one with *Trypanosoma vivax*. Infected animals had significantly less Packed Cell Volume PCV than non-infected animals (22.0 vs. 24.3). Farmers mainly recognized the disease by the following symptoms: Diarrhoea, hair loss, weight loss, coughing and change in skin colour. About 94 % of the farmers mentioned other ways than Tsetse fly as transmitter for the disease. These results were reported and discussed with the farmers. The project is undertaking further efforts to fill the knowledge gap and introduce sustainable disease control measures in the next two years.

Keywords: Farmers' perceptions, *Trypanosoma congolense*, *Trypanosoma vivax*

Contact Address: Simon Riedel, Georg-August-University Göttingen, Biotechnology, 53227 Bonn, Germany, e-mail: simonriedel@gmx.de

Interactions of Shrimp and Rice Farming Systems in Southern Thailand: How Can We Internalise the Unidirectional Externalities?

SIRIRAT KIATPATHOMCHAI, MICHAEL. P SCHMITZ, T. S. AMJATH BABU
Justus-Liebig University Giessen, Institute of Agricultural Policy and Market Research, Germany

Rice farming, a dominant economic as well as culturally important activity in Thailand is affected by the prevailing low prices of the rice grain in domestic and international markets as well as the raising cost of cultivation and opportunity costs. The current bleak scenario is exacerbated in southern Thailand especially in the Songkha Lake Basin due to prevailing low productivity of rice crop. Further deteriorating the situation, an increasing trend of myopic conversion of rice fields to shrimp farms for short term gains are gaining momentum especially from the late 1980s. Even though the initial gains were substantial for rice field turned shrimp farms, this is proved to be unsustainable. Here we are looking at the unidirectional externalities originating from the conversion which brings the productivity of rice fields further down. It can be observed that the fields in the coastal areas were converted initially but were extended to the inland making more area be saline which is essential for shrimp cultivation but deleterious for rice farming. The external effects originate from the saline effluences discharged to common irrigation canals which may 1) destroy the soil structure and 2) retard the growth of rice and hence 3) decrease the efficiency and productivity of farming. In the present study, a quantification of external effects on rice farming using the primary survey data supported by data from secondary sources is attempted. The fiscal and non-fiscal measures of internalising this externality is sought after but we would like to concentrate on non-fiscal solutions especially by allocating property rights to farmers. The importance of the work lies in the fact that rice farming which is proved to be a sustainable agricultural activity in southern Thailand may loose its existing area share to unsustainable farming systems if the market failures are not corrected as soon as possible and one has to consider the fact that the re-conversion of shrimp farms back to rice fields are prohibitively costly and hence the change is economically almost irreversible.

Keywords: Externality, Rice Farming, Shrimp Farming, Southern Thailand, sustainability

Contact Address: Sirirat Kiatpathomchai, Justus-Liebig University Giessen, Institute of Agricultural Policy and Market Research, Diezstr.15, 35390 Gießen, Germany, e-mail: Sirirat.Kiatpathomchai@agrar.uni-giessen.de

Milk Production in the Global Market: the Adaptation of Small Farmer in the State of Rio Grande Do Sul, Brazil

VICENTE C PIRES SILVEIRA, FABIANA ANDREIA FICK, ROSANE MARIA CORADINI NOAL, MARCOS ALVES DOS REYS

Federal University of Santa Maria, Agricultural Education and Rural Extension, Brazil

The Brazilian milk production chain presents two historical moments. In the first moment the government interveined by fixing milk and dairy product prices. During this period, the dairy industry was formed by small and medium sized companies, which made the presence and participation of state companies and cooperatives become extremely important. During the second moment, since the beggining of the 90s, there is free market due to the globalisation of world economy. In the dairy sector fixed price was eliminated and there was a concentration of dairy industry and distribution sector. The government and cooperatives began to play an secondary magnitude, practically as mediators of the supply of raw matter or small industrial units of regional level. During this period, the goods and services market began to be dominated by global companies. In the state of Rio Grande do Sul, milk production was submitted to an intense transformation process, pressiored by external and internal economical factors. The rearticulation process of this sector under the free market point of view allowed the creation of a production approach based on raw matter demand, where low production costs combined with product quality became the main point of this activity and the focus of industrial strategy in order to become comercially competitive in the global market. In Rio Grande do Sul milk production is concentrated in small farm than the national average, in areas of up to 50 hectares, being that these properties are responsible for 84.3 % of the total production. The implementation of tools at a farm level, which can assist in the milking of cows in a more hygenic way, allied to the monitoring of production indicators are other means of helping small farmers which are willing to maintain themselves in this sector which continues to become more competitive. To know technical and economical results is of great importance since it is possible to evaluate farmer capitalisation and decapitalisation processes, allowing a deeper study of social relations which characterise the production and farming systems as a whole.

Keywords: Dairy farmer, dairy sector, Milk production, Milk quality

Contact Address: Vicente C Pires Silveira, Federal University of Santa Maria, Agricultural Education and Rural Extension, Sala 5112b Predio 44, 97105-900 Santa Maria, Brazil, e-mail: vicentesilveira@smail.ufsm.br

Endogenous Development of Pastoral and Livestock Communities in Nigeria: Role of Research

JEROME GEFU

Ahmadu Bello University, National Animal Production Research Institute, Shika, Nigeria

Extensive pastoral production occurs in some 65 % of Africa's drylands. It provides 10 % of the world's meat production and supports some 200 million pastoral households keeping nearly a billion head of ruminants. Smallholder livestock remains critical to millions of people living in poverty. In West Africa, some 30 million pastoralists apply a variety of production strategies, including husbandry and health practices, feeding and marketing strategies. In many parts of Africa pastoralists have maintained indigenous animal breeds of varying gene pool that are well adapted to harsh environments. Their production systems are still widely informed by indigenous knowledge and practices, which span several generations. However, pastoralism is increasingly under pressure due to increasing and varied demand for livestock products. The need to expand and adapt has, therefore, become imperative. Following scientific verification of some common pastoral production practices and techniques through applied research, viable aspects of traditional practices could be incorporated into modern scientific techniques and systems for improved production. Applied research aims at providing good understanding of the nature and dynamism of production systems from which appropriate policy and institutional changes required to positively influence livestock production would emerge. This research orientation is a departure from the usual research activities that are often geared towards the production of peer-reviewed publications that are often required for professional mobility of research officers. Applied research cum community-led development initiatives, rather than injection of values and ideas alien to the community, stands better chance of impacting positively on the livelihoods of producers, as producers exercise greater control over their destiny with minimal external input. The paper draws on results of recent applied research in pastoral communities in Nigeria. It documents and classifies various livestock health delivery and production systems with practical relevance to improved production in pastoral communities. The research results have had positive influence on government policy of integrating traditional practices and technologies into scientific procedures of animal health and production.

Keywords: African pastoralist, applied research, endogenous livestock development, production systems

Contact Address: Jerome Gefu, Ahmadu Bello University, National Animal Production Research Institute, Shika, PMB 1096, 800001 Zaria, Nigeria, e-mail: jgefu@yahoo.com

Supply Chain Interventions for the Benefit of Small Fishery Producers: Case Studies from the Philippines

EUSEBIO JACINTO

Tambuyog Development Center, Philippines

In the Philippines, small-scale fisheries, as common pool resources, remains beset by the problems of resource degradation and widespread poverty in coastal communities. Community-based coastal resources management (CBCRM) approaches centreed on property rights are being increasingly adopted by fisherfolk and non-government organisations as both tactical necessity and strategic imperative.

With the CBCRM movement in the Philippines entering its second generation, there have been both successes and failures. There have been substantial gains in the area of resource conservation especially with marine protected areas as one of the main strategies being employed. However, this stands in stark contrast to assertions of small-scale fishers that they do not benefit economically from the market from their crucial role in coastal resource management.

This dilemma of market disempowerment is further embedded in the phenomenon of rapid global economic integration, which if not properly managed, threatens to exacerbate the plight of coastal communities. To deepen the investigation into the situation of small-scale fishers vis-à-vis other economic players at the local, national and global level, case studies analysing the supply chain were conducted on selected fishery products, including tuna, milkfish and seaweed.

These studies focused on the dynamic of interlinkages in the fishing industry and sought to describe the full range of activities required to bring fishery products from capture/culture, through the different phases of production and delivery to final consumers. Based on these studies, development interventions were initiated by local associations of small fishery producers with support from government agencies and non-government organisations. These interventions include enhancement of property rights arrangements, mitigation of externalities caused by fishery activities, and measures towards supply chain integration.

The case studies will also highlight palpable changes, from the perspective of small producers, in the areas of governance and distribution of benefits along the supply chain with focus on sourcing of inputs, stability of resource tenure, and development of independent capacity in marketing and processing.

Keywords: Community property rights, community-based coastal resources management, small-scale fishers, supply chain, value chain analysis

Contact Address: Eusebio Jacinto, Tambuyog Development Center, 91 V. Luna Rd. Ext. Cor. Maningning St. Sikatuna Village Diliman, 1101 Quezon City, Philippines, e-mail: ted@tambuyog.org

Ethnoveterinary Medical Traditions and Methodology for their Documentation, Assessment and Promotion

BALAKRISHNAN NAIR

Foundation for Revitalization of Llocal Health Tradition, Community Health Education and Outreach, India

Nearly 70 % of the world's rural poor depends on livestock as a critical component of their livelihood. It is estimated that approximately Rs 50 billion are lost annually on account of livestock diseases in India. Modern veterinary health delivery is facing many constraints such as high treatment cost, inaccessibility and presence of antibiotic and hormonal residues in the milk and other animal products. Veterinary services have a crucial role in controlling highly contagious diseases and zoonotic infections, which have implications for human health as well as that of livestock. The Indian subcontinent has rich ethnoveterinary health traditions which are the products of decades of experiences. These traditional medicines can be used for the animal health care that can cut down the cost considerably. Moreover they are readily accessible to the ordinary farmer. The key challenges are to find out the effectiveness and contemporary relevance of these practices. The modern laboratory and clinical studies for validation involve long time and huge resources. The worldview of the theoretical foundation of modern science and the traditional knowledge are completely different. Therefore, it is necessary to have an assessment which involves world view which is nearly similar to the traditional knowledge and practices. An Ayurveda/Mrugayurveda based Assessment methodology was developed in order to find the safe and efficacious ethnoveterinary practices in select locations of South India. A total of 116 plant species for 19 health conditions that are commonly seen in cattle were taken for assessment in different geographical locations. The basic principle of this assessment is a consensus of opinion among different medical systems about the management of a health conditions. It was found that nearly 70 % of the practices had supportive evidence from Ayurveda (one of the Indian systems of Medicine) and modern pharmacology on their prescribed uses.

Keywords: Endogenous livestock development, ethnoveterinary health traditions

Contact Address: Balakrishnan Nair, Foundation for Revitalization of Llocal Health Tradition, Community Health Education and Outreach, 74/2 Jarakabande Kaval Attur Post via Yelahanka, 560 064 Bangalore, India, e-mail: nair.mnb@frlht.org

Farmers' Preferences of Phenotypic Traits in Cattle Production and Marketing: A Case Study in Central Ethiopia

GIRMA TESFAHUN KASSIE[1,2], CLEMENS WOLLNY[2,1], AWUDU ABDULAI[3], ADAM DRUCKER[4,2], WORKNEH AYALEW[2]

[1]*Georg-August-University Göttingen, Animal Breeding and Husbandry in the Tropics and Subtropics, Germany*

[2]*International Livestock Research Institute, (ILRI), Ethiopia*

[3]*University of Kiel, Department of Food Economics and Consumption Studies, Germany*

[4]*Charles Darwin University, Australia*

Production and marketing decisions in the semi-subsistence cattle keeping systems of Ethiopia are principally influenced by farmers' preferences of cattle phenotypic traits. Eliciting the preferences and quantifying the economic worth of these characteristics would reinforce efforts in the production, marketing, and sustainable conservation and use of animal genetic resources (AnGR). This study focused at understanding what farmers and farmer-buyers' preferences are regarding the cattle they want to buy and/or keep or sell. The research was conducted in and around Dano district of Central Ethiopia both on farm and in the cattle markets. Farmers, as cattle keepers, identified age, origin, and suitability for ploughing for oxen/bulls and age, fertility, origin of the animal, and calf strength for cows/heifers as the most important traits. As cattle buyers, farmers selected age, suitability for ploughing, origin of the animal, and calf strength for oxen/bulls and age, origin, milk yield and calf strength for cows/heifers as the crucial traits in their buying decisions. Spearman rank-order correlation coefficients showed that covariations of farmer rankings are strong and mainly occur along the upward slant. The research verified the fact that farmers have age-old mechanisms of identifying and ranking their trait preferences in a consistent and meaningful manner. The identification of these trait preferences implies that decisions for genetic improvement and conservation of indigenous cattle in these production systems should be based on comprehensive understanding not only of the relative importance attached to each phenotypic trait but also of the ways in which cattle keepers and consumers measure these traits.

Keywords: Cattle buyers, Cattle keepers, Covariation, Dano, Trait preferences

Contact Address: Girma Tesfahun Kassie, Georg-August-University Göttingen, Animal Breeding and Husbandry in the Tropics and Subtropics, Kellnerweg 6, 37077 Göttingen, Germany, e-mail: gkassie@gwdg.de

Direct Involvement of Indigenous Women in Sheep Improvement Research in Chiapas, México

RAUL PEREZGROVAS

University of Chiapas, Institute of Indigenous Studies, Mexico

In developing countries, animal extension approaches utilise the introduction of exotic genes as the basis for crossbreeding interventions. Most of these efforts end up failing due to lack of adaptation of the high-performance breeds. In Highland Chiapas, the Tzotzil ethnic group derives up to 36 % of its income from sheep husbandry and the weaving of typical woolen clothes; government efforts have attempted to absorb the local wool sheep with high-producing breeds such as the Merino, without success.

A different approach tried to improve fleece quality in Chiapas sheep by selection, and a research project was designed utilising an open nucleus scheme. Commercial or industrial traits of high-quality wool (white, short, fine) were exactly the opposite of those developed by the local weavers (coloured, coarse, double-coated, long). To account for the difference groups of Tzotzil shepherdesses and weavers were invited in 1996 to collaborate as part of the sheep-improvement plan, directing research goals by means of their continuous assessment of fleece-quality in the animals of the nucleus flock. This collaboration is put into practice by grading the quality of the fleece in all sheep under 24 months of age, prior to each six-monthly shearing.

The list of achievements in the first 10 years of this unique inter-ethnic collaboration includes a set of selection objectives for fleece quality, and a comprehensive understanding of the characteristics of wool in the local sheep and its relationship with the transformation of wool into clothes through the ancient textile process utilised over centuries by the Tzotzil women. As a result, current fleece variables within the improvement programme include: fleece quality, staple length, textile aptitude (proportion of coarse/fine fibers), greasy fleece weight, and wool growth. Improved rams from the nucleus flock have been introduced within community flocks, and their offspring have inherited superior fleece-quality traits. Direct participation in the programme by the local experts in sheep husbandry and weaving, has been a key issue in the success of this endogenous research approach.

Keywords: Endogenous livestock development, fleece quality, Tzotzil shepherdesses

Contact Address: Raul Perezgrovas, University of Chiapas, Institute of Indigenous Studies, Centro Universitario Campus III, 29264 San Cristóbal de Las Casas, Mexico, e-mail: rgrovas@unach.mx

How to Sustainably Increase the Proportion of Males in Nile Tilapia (*O.niloticus*) by Temperature Treatment: A two Generation Selection Experiment for Thermal Sensitivity

STEPHAN WESSELS, GABRIELE HÖRSTGEN-SCHWARK
Georg-August-University Göttingen, Institute of Animal Husbandry and Genetics, Germany

Stunting still is one of the major problems in production of mixed sex Nile Tilapia stocks. Thus all-male stocks are highly desirable in cultivation of Nile Tilapia. High temperature treatments are capable of changing the phenotypic sex towards maleness. Loss of productivity due to early recruitment in the ponds could be minimised by selection of temperature sensitive lines to sustainably increase the proportion of males by temperature treatment. Therefore a selection experiment over two selection generations was carried out starting with 36 families of *Oreochromis niloticus* from Lake Manzala (Egypt) as a base population.
In order to detect the families‘ thermal sensitivity they were subdivided into a control (28°C) and treatment group, each consisting of 110 fish. The treatment groups were subjected to a 10 day thermal treatment at 36°C water temperature starting 9 days post fertilisation. After gradual readaptation to 28°C each treatment and corresponding control group was raised separately till sexing (microscopical inspection of gonads at a minimum age of 90 days). For later selection purposes 10 males and females were kept from each control group. Families showing the highest surplus of males in the temperature treated groups were selected. Hence, 14 % of the families in the base population and first selection generation were selected. Two generations of selection increased the male percentage in the temperature treated groups to more than 90 %. High response to selection and a high realized heritability of 0.83 indicated that temperature sex determination has a strong genetic background. Thus, production of temperature sensitive lines seems to be a feasible approach to significantly increase the percentage of males in a consumer- and environment-friendly way.

Keywords: Male percentage, Nile Tilapia, realized heritability, selection, temperature treament

Contact Address: Stephan Wessels, Georg-August-University Göttingen, Institute of Animal Husbandry and Genetics, Albrecht-Thaer-Weg 3, 37075 Göttingen, Germany, e-mail: swessel@gwdg.de

Dairy Cattle for Poverty Alleviation in Southern Tanzania

WOLFGANG BAYER[1], LUCAS BASILIO KAPUNDA[2], PHILIP SASSOON[2]
[1]*Independent Advisor in Livestock Systems Development, Germany*
[2]*Caritas, Mbyea, Tanzania, Southern Highland Network, Tanzania*

In the past half-century, various ways of increasing dairy production have been tried in Tanzania, with the "Heifer in Trust" (HIT) scheme being the most successful. A group of farmers receives a small number of exotic dairy heifers (mostly Holstein-Friesian crosses) and distributes the animals to individual families. Farmers are obliged to keep the cows indoors, are advised to make compost with the manure, and have to repay two calves per heifer received: one to the group to be passed on to another group member and one to the project to cover expenses. A recent study in the southern highlands of Tanzania examined the effectiveness of this approach in alleviating poverty.

In the highlands, high-grade dairy animals can produce 5000 l of milk/lactation or more if they receive adequate amounts of concentrates; at lower elevations with higher disease pressure, lower-grade animals fare better. Income from milk sales helped the smallholder families to acquire additional land, improve their houses (and cattle sheds), finance small-scale businesses, send children to secondary school, and expand the dairy business. Manure helped double the maize yield and improve yields of cash crops (tomatoes, bananas). Keeping dairy cattle stimulated farmers to drill shallow wells. Partnership between spouses has reportedly improved through the loan agreement. Families that barely managed to survive six years ago are now considered wealthy. Milk marketing is presently not a problem, although it may need attention in future.

However, only 2—3 % of households in any village are reached by the HIT scheme and its success depends on good functioning of the farmers' groups. Whereas some groups could increase dairy cattle keeping from initially 5 to 25 households within six years, other groups stagnated or failed. It was also found that the project has reached mostly the moderately poor and able-bodied people and that dairy production is most successful in peri-urban areas.

Keywords: Credit, dairy cattle, manure, poverty alleviation, Tanzania

Contact Address: Wolfgang Bayer, Independent Advisor in Livestock Systems Development, Rohnsweg 56, 37085 Göttingen, Germany, e-mail: wb_bayer@web.de

Evaluation of Animal Production Systems

Determining High Potential Aquaculture Production Areas — Analysis of Key Socio-economic Adoption Factors

DIEMUTH PEMSL, MADAN M. DEY, FERDINAND J. PARAGUAS
WorldFish Center, Policy, Economics, and Social Sciences, Malaysia

Aquaculture production increased with an average 10 % annual growth rate since 1990 and today some 90 % of aquaculture production takes place in developing countries thus providing livelihood and income especially to marginal groups without access to resources such as agricultural land.

A project coordinated by the WorldFish Center is developing a GIS-based decision support model to facilitate the prioritising of national research, development and extension strategies and targeting of development assistance for aquaculture in the partner countries (Cameroon, China, Bangladesh, Malawi). Stakeholders need to know where and under which conditions certain aquaculture technologies would be feasible. Factors that determine the adoption of certain technologies include agro-physical (rainfall, temperature, soil type, slope) and socio-economic (availability of land, labour, and capital, infrastructure, input supply) characteristics. The input of agro-physical factors in the model is straight forward by generating maps showing the rainfall or temperature of a certain area. However, many important socio-economic variables are not explicitly spatially distributed (such as household land holdings or education).

Four main stages are used to integrate socio-economic variables in the GIS based decision support model: **(1)** identification of key factors for successful adoption of target technologies on the micro-level, **(2)** development of indicators on the meso-level, **(3)** generation of input data sets (geo-referenced) for the GIS model, and **(4)** assignment of ranking/weights to the indicators. The paper outlines the conceptual framework used for the socio-economic part of the decision support model and highlights some of the inherent methodological challenges. Results of the analysis of aquaculture adoption in Bangladesh and Malawi, representing different levels of intensification of aquaculture production are presented and discussed. Spatial econometric techniques are used to assign ranks to the developed indicators.

Keywords: Adoption of aquaculture, decision support model, developing countries, spatial econometrics

Contact Address: Diemuth Pemsl, WorldFish Center, Policy, Economics, and Social Sciences, Penang, Malaysia, e-mail: d.pemsl@cgiar.org

Effects of Shelter on Survival- and Growth Rate of Giant Freshwater Prawn (*Macrobrachium rosenbergii* de Man) During Post Larvae Stages

ADE SUNARYO[1], M. AGUS SUPRAYUDI[2], STEPHAN WESSELS[1], GABRIELE HÖRSTGEN-SCHWARK[1]

[1]*Georg-August University, Institute of Animal Husbandry and Genetics, Germany*

[2]*Bogor Agricultural University, Marine Culture and Fisheries Faculty, Indonesia*

One of the major constraints in the culture of giant freshwater prawn (*Macrobrachium rosenbergii*) is the low survival rate during the post larvae phase due to cannibalism. The objective of this experiment was therefore to evaluate the effects of shelter on survival- and growth rate of post larvae. Experiments were carried out at the hatchery of the Bogor Extension Fisheries Programme, Bogor, Indonesia. Aquariae, each with a water volume of 100 litres, were stocked with post larvae (PL) of an average weight of 0.02 g at a density of one PL per litre. After acclimatisation, PL were fed with commercial pelleted feed of 1mm diameter. Five different shelter types were evaluated: multiple vertical shelter (B), single diagonal shelter (C), zigzag shelter (D), horizontal single shelter (E), and a combination of vertical and horizontal shelter (F). Each shelter type and a control without shelter (A) was tested in triplicate (18 aquaria) over a period of 60 days. Thereafter PL were counted and weighted again. Water quality parameters (temperature, pH, oxygen, nitrite, ammonia) were measured daily during the whole experimental period. The results of the experiments clearly showed that each type of shelter in comparison to the controls improved the survival rate significantly. The highest survival rate with 53 % was obtained by using a combination of vertical and horizontal shelter (treatment F). The final average weight of PL was also highest in treatment F (3.38g) and differed significantly from the weight observed in controls (2.87g). Results of these experiments should be also examined under pond conditions.

Keywords: Growth rate, post larvae, shelter, survival rate

Contact Address: Stephan Wessels, Georg-August-University Göttingen, Institute of Animal Husbandry and Genetics, Albrecht-Thaer-Weg 3, 37075 Göttingen, Germany, e-mail: swessel@gwdg.de

Smallholder Sheep and Goat Production Systems in Southern Ethiopia: Opportunities and Limitations

GETAHUN LEGESSE GIZAW[1,2], MARIANNA SIEGMUND-SCHULTZE[1], GIRMA ABEBE[2], ANNE VALLE ZÁRATE[1]

[1] *University of Hohenheim, Animal Breeding and Husbandry in the Tropics and Subtropics, Germany*

[2] *University of Hawassa, Department of Animal and Range Sciences, Ethiopia*

Small ruminants are an integral part of mixed-farming systems throughout Ethiopia. Assessment of the existing small ruminant production systems is an important tool to inform researchers about the actual problems farmers face and the opportunities that exist within the systems. A survey was conducted from April to July 2004 in the Adilo and Kofele areas of the mixed farming systems of southern Ethiopia. Adilo is one of the most densely populated areas in Ethiopia. Kofele represents southern highlands populated at medium level and the farmers keep more livestock and own bigger farmland than their counterparts in Adilo. Following the identification of the major small ruminant supplier localities to the markets in the study area, ten of them were purposefully selected from each study site for further sampling. Then, an average of twenty households was randomly selected from each locality, totalling 399 households. A structured questionnaire was used to collect data on productive and socioeconomic aspects which were later validated by group discussions. Small ruminants hold several roles in the study sites. They provide meat, milk and skins; however, the principal purpose of keeping sheep and goats is to generate income. Sheep milk consumption is widespread around Kofele unlike most agricultural systems in the country. Nearly all respondents in Adilo (93 %) reported that they fatten their animals for sale. Lack of feed which is directly related to the shrinking farm size was ranked as a major constraint by Adilo respondents while small ruminant diseases ranked as a topmost priority problem in Kofele. The growing demand for small ruminants both in local and international markets, the improving transportation infrastructure, and the experience of farmers in small ruminant keeping are practical opportunities to enhance the contribution of the sector. This study has produced a general understanding of the small ruminant systems and identified major challenges. A thorough monitoring of the productive and economic performance of small ruminants is required to capture full picture of their contribution thereby directing possible intervention areas to maximise benefits to the farmers.

Keywords: Ethiopia, mixed-farming systems, small ruminants

Contact Address: Getahun Legesse Gizaw, University of Hohenheim, Animal Breeding and Husbandry in the Tropics and Subtropics, Garbenstrasse 17, 70593 Stuttgart, Germany, e-mail: getahun@uni-hohenhem.de

Strengthening Livestock Market Flows and Feeding Practices for Improved Livelihoods in Southern Zimbabwe

SABINE HOMANN, ANDRE VANROOYEN
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Zimbabwe

The growing demand for livestock products offers income opportunities for small-scale farmers in semi-arid areas of Zimbabwe provided they could increase off-take rates and improve animal quality. To achieve this, farmers need to increase their investments in feeding methods and practices — but with poorly developed markets for livestock products and services, farmers have little incentive to make the necessary investments.

We conducted household surveys on cattle and goat production in three districts in Zimbabwe, at sites with differences in market access (proxied by distance to nearest market) and human population densities. The survey examined off-take rates, management practices and socio-economic profiles of livestock keepers. In addition, focus group discussions with livestock traders provided information on market opportunities and input technologies required.

Cattle provide only limited income, although they are the preferred form of investment. Goats are sold more often, to meet household expenses. Farmers use formal market systems in remote areas, while they choose informal marketing strategies in areas closer to urban markets — bypassing levies and transaction costs. Significant numbers of cattle offered for sale at official sales-pens are not sold — largely as a result of low prices offered by buyers due to poor animal quality or because of imperfect market situations where few buyers dictate very low prices. For goats no formal markets exist, but large numbers are sold to traders and then transported to urban areas, where demand is high. Prices are also low and variable during the year, because of a lack of market competition and poor animal condition.

The main challenges are to improve livestock markets and disseminate market information to small-scale producers. Premium prices paid for animals in better conditions will create the incentives for farmers to invest in improved animal feed and management technologies. This will require joint investments by both private and public sectors.

Keywords: Animal feed and management technology, crop-livestock farming systems, livestock market development

Contact Address: Sabine Homann, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Po Box 776, Bulawayo, Zimbabwe, e-mail: s.homann@cgiar.org

Stimulating Milk Production in Cameroon - Meeting the Challenges

OGHAIKI ASAAH NDAMBI[1], VOLKER HOFFMANN[2], BAYEMI HENRI[3]

[1]*IFCN Dairy Research Center, Germany*

[2]*Universität Hohenheim, Department of Agricultural Communication and Extension, Germany*

[3]*Institute of Agricultural Research for Development Bambui, Bovine Production, Cameroon*

Cameroon falls within counties with the lowest per caput production and consumption of milk. The per capita consumption of milk in Cameroon is about 15 Kg milk equivalents per year, compared to 40 Kg in Africa and 94 Kg in the world. Milk has been envisaged as a principal protein source that can raise protein consumption and hence reduce malnutrition, which is still a major problem to Cameroon, with a prevalence of 22 % in children less than 5 years. Due to urbanisation and population growth, milk production per head is expected to double by the year 2020, in order to meet demand. This study was intended to assess the opportunities and constraints to dairy development in Cameroon. Data was collected through visits and execution of individual interviews to farmers and other stakeholders, using questionnaires.

Results showed that dairying development has a potential revealed by: availability of demand and importation of dairy products especially in urban areas, availability of processing plants, resistant cattle breeds, labour force, veterinary, research and extension services. Milk production was however dominated by Fulani herders, who owned local cattle breeds, stayed far from markets, had land disputes with crop farmers and suffered from feed shortage, especially in the dry season.

Improved feeding and livestock management could lead to a tripled average daily milk yield of local cows. Exotic breeds could produce higher amounts of milk; however, their high costs of production and low adaptability are a problem to farmers. Crossbreeding could produce better results; however, research still needs to be done to show profitable levels and acceptable scale of production. Market availability and access to extension, veterinary and credit services could stimulate milk production in rural areas.

Furthermore, the organisation of farmers into dairy cooperative groups can be recommended as a means of fostering their production, marketing and credit worthiness hence improving on income generation from dairying.

Keywords: Cameroon, Constraints, dairy development, Opportunities, Research

Contact Address: Oghaiki Asaah Ndambi, IFCN Dairy Research Center, Bohlweg 55, 38100 Braunschweig, Germany, e-mail: ndamboa@yahoo.com

How to Meet Future Demand for Animal Products: the Case of Benin

INA GRUBER

University of Bonn, Institute for Food and Resource Economics, Germany

At present the livestock sector in developing countries undergoes several changes on the way to development. Population growth, stagnant productivity and extensive production methods which are based to a large extent on the use of natural resources lead to high demand combined with limited production. This situation is also the case in Benin producing animal products mainly for own consumption including gifts and sacrificing, for improving household income of small farmers and for regional trade. Connections to the world market are in general weak, but frozen chicken and eggs are imported in large amounts. Benin will face an over proportional increase in demand for animal products due to its high population growth and an expected income growth per capita. The latter is relevant as income elasticities are greater than one for high protein products such as animal products in this region. This increasing demand of about 134 % up to 2025 could be satisfied by changing the production method towards a more intensive system, increasing herd size or increasing import quantities. The further developed Agricultural Sector Model BenIMPACT studies the possibilities to meet the higher demand for animal products in the future. In the new version the livestock sectors is integrated into the model affording the opportunity to analyse and discuss the future development as well as international trade of animal products. The results are confronted with expert opinions which were evaluated in a field survey in October/November 2005. The experts stated that additional quantities will be mainly provided by intensification. They also assume that an expansion in animal numbers is a method for higher supply. However they projected small increases in productivity for the next twenty years why it seems obvious that without the connection to the world market the expected demand cannot be met.

Keywords: Agricultural sector model, Development, livestock management

Contact Address: Ina Gruber, University of Bonn, Institute for Food and Resource Economics, Nussallee 21, 53115 Bonn, Germany, e-mail: gruber@agp.uni-bonn.de

Buffalo Production: A Prosperous Enterprise to Empower Women Farmers and to Sustain Subsistence Farming

LILA KARKI[1], SIEGFRIED BAUER[1], UMA KARKI[2]

[1]*Justus-Liebig-University Giessen, Institute of Agriculture and Food Systems Management, Germany*

[2]*Auburn University, College of Agriculture, USA*

Livestock is a paramount component in Nepalese agricultural system. Its economic contribution to rural households (28.5 %), agricultural sector (31.5 %), and national economy (18 %) is in increasing trend. However, the share of animal products in Nepalese dietary energy supply is merely 7.5 %. Buffalo contributes 69 % and 64 % to the total milk and meat production respectively. Besides, manure and draft power have been two key outputs that buffalo provides to maintain the soil fertility and agricultural operations, where chemical fertiliser and mechanisation have not often been practised. However, buffalo production has not yet been accorded top priority in the livestock sector. The study was conducted in the mid hills of Nepal. The field data were collected applying multi-stage random sampling technique. The collected data have been analysed using descriptive statistics, econometric models, and qualitative tools. Additionally, annual compound growth rate of buffalo population and their production and factor productivity have been analyzed. The model results reveal high possibility to increase factor productivity by utilising the available farm resources optimally. The highest economic contribution of buffalo to all other farm animals (cow, goat, sheep, poultry) underpins its production potentialities in livestock based farming system. The involvement of women in production and marketing activities also analyzed. The significant involvement of women in raising buffalo activity opens possibilities of empowering them through human capacity development and income generating prospects. The socio-economic contribution of this enterprise to the rural households can further be increased substantially if farmers are made aware of the concept comparative advantage and motivate them accordingly. Simultaneously, government have to provide farmers with some other strategic interventions in order them to facilitate applying modern buffalo technology, enhance their technical and managerial capacity and constant support on diversifying the products to ease marketing.

Keywords: Buffalo enterprise, factor productivity, rural economy, women empowerment

Contact Address: Lila Karki, Justus-Liebig-University Giessen, Institute of Agriculture and Food Systems Management, Senckenbergstraße - 3, D-35390 Gießen, Germany, e-mail: Lila.Karki@agrar.uni-giessen.de

A Methodology to Measure the Costs of Animal Trypanosomosis in West Africa

HIPPOLYTE AFFOGNON[1], HERMANN WAIBEL[1], DELIA GRACE[2], THOMAS RANDOLPH[3]

[1]*Leibniz-University Hannover, Economics and Business Administration, Germany*

[2]*Free University Berlin, Institute of Parasitology and International Animal Health, Germany*

[3]*International Livestock Research Institute (ILRI), Livestock & Human Health, Kenya*

This study assesses the farm level costs and the productivity of drugs used for controlling trypanosomosis, a serious cattle disease and major constraint to agricultural production in West Africa. Trypanocide drug treatments are the principal method of control but emerging resistance to these drugs threatens the sustainability of their continued use. The study was conducted in West Africa in Burkina Faso and Mali from June 2003 to May 2004. Data were collected by a team of veterinary epidemiologists, technicians and agro-economists. In all, 208 herds with a total of 3565 cattle in 18 villages were monitored during a period of 12 months. Epidemiological data were collected three times (the rainy season, the dry cold season and the dry hot season). Input and output data were collected by enumerators posted in the villages throughout the study period. Additional price data were collected in local markets and abattoirs. The methodologies of data analysis included Analysis of Variance (ANOVA) adjusted for clustering and a production function model integrating a damage control function. Resistance was captured by including a dummy variable for trypanocide drug failure. Results show that depending on epidemiological conditions, trypanosomosis costs, at farm level, 8.76 to 24.71 [€/TLU/Year] (Cost of trypanosomosis is composed of the production loss due to the disease plus the costs of disease abatement). The costs of the disease represent 8 % to 22 % of annual household cattle production revenue per Tropical Livestock Unit (TLU). Farmers in villages with high disease prevalence and high drug resistance realise significantly less output on average than those in low prevalence and low resistance villages. Where disease is common, there is significantly less total output (29.5 %) in the presence of high versus low drug resistance. The marginal value products of trypanocides vary but are positive and greater than one. In economic terms, this implies that contrary to common opinion, farmers tend to under- rather than over-use trypanocide drugs. Based on the results, recommendations are made for introducing an extension system that promotes rational use of trypanocides to avoid inefficiency of input use.

Keywords: Costs of disease, damage control, productivity, resistance, trypanocide, trypanosomosis

Contact Address: Hippolyte Affognon, Leibniz-University Hannover, Economics and Business Administration, Königsworther Platz 1, 30167 Hannover, Germany, e-mail: haffognon@yahoo.com

Analysis of the Potential Contribution of Improvements in the Livestock Production System to Better Livelihood of Small Farmers' Households: Livestock Production System Model as Represented by Major Actors

DAO DAOUDA[1], LEHMANN BERNARD[2], DUMONDEL MICHEL[2]

[1]*University of Cocody, Center of Scientific Research, Ivory Coast*
[2]*Swiss Federal Institute of Technology (ETH), Agrifood and Agrienmvironmental Economics Group, Switzerland*

Livestock production plays an important role in the economies of many African countries. In Côte d'Ivoire, rapid population growth (3.8 % in 1999) and urbanisation have modified dietary customs. There is a fast growing consumer demand for meat, eggs, and milk, which cannot be satisfied by local production alone (31 % for meat and 11 % for milk). Both constraints at the production level as well as poorly adapted and inefficient local, commercial networks characterise the system. The consequence is high transportation costs lead to a qualitatively and quantitatively inadequate supply of livestock products to urban centres from the countryside.
Acknowledging this inefficiency, this project is funded by ZIL and aimed to provide a detailed description, analysis, and understanding of the local livestock system. Team learning is increasingly recognised as a critical factor in tackling strategic problems. Considering all the points above, we have tried to interlink all the participants in the livestock production process through a systems approach using group modelling (Vennix, 1996). Vennix group modelling is a process whereby all participants exchange their perceptions of the origin of a problem and analyse its causes and their effects on the dynamic evolution of this problem. The preferred partners has been key stakeholders in cattle, small ruminants and poultry production, starting with farmers and including co-operatives and consumer associations, veterinarians, drug retailers and sellers, development agencies, the Ministries of animal production of agriculture, trade and their local representatives and NGOs. The mapping and modelling process recommended by Sterman (2000) and Vennix (1996) has been used and adapted to the context of livestock production in Côte d'Ivoire. On this poster, we present the first model which reflects the views of the major actors.

Keywords: Côte d'Ivoire , Efficacy, Group Model building, livestock

Contact Address: Dao Daouda, University of Cocody, Center of Scientific Research, 01 Bp 1303 Abidjan 01, Abidjan, Ivory Coast, e-mail: daouda.dao@csrs.ci

Uniting Cattle Production and the Provision of Environmental Services on the Same Plot: An Analysis of Farmers Costs, Benefits and Incentives to Adopt Silvopastoral Systems in Costa Rica, Nicaragua and Colombia

GESINE HAENSEL[1], MUHAMMAD IBRAHIM[2]

[1],

[2]*Center for Research and Higher Education in Tropical Agriculture (CATIE), Agroforestry, Costa Rica*

Driven by a growing world population and rising incomes, the demand for livestock in developing countries is expected to double over the next twenty years. This trend gives reason for concern that an expansion of livestock production will put additional pressure on natural resources. At the same time, this quickly growing demand opens a unique opportunity for small-scale livestock farmers to enter markets as suppliers and to enhance their household welfare through additional income. One important challenges associated with this trend is finding ways of linking the promotion of sustainable livestock production systems with the provision of adequate incentives for their adoption. The GEF project "Integrated Silvopastoral Approaches to Ecosystem Management" is testing a novel approach which has potential to meet this challenge. It uses payments for environmental services (PES) as an incentive for the adoption of silvopastoral practices on degraded pasture land in Costa Rica, Nicaragua and Colombia. Small and medium sized farmers are rewarded with payments for the provision of global environmental services generated by silvopastoral systems. Payments are issued over a period of two to four years to cover parts of up-front investment costs. Once payments end, the systems are expected to generate returns which exceed those of traditional land-use practices thus providing the basis for their long-term sustainability. The present paper analyses farmers' costs and benefits of adopting silvopastoral systems in three different countries and identifies socio-economic characteristics of farm households which favour/impede their adoption. To shed light on the question whether transaction costs constitute a barrier to small-scale farmers' participation in PES systems, transaction costs of farmers are measured who participate in Costa Rica's national PES scheme. Based on those findings, suggestions are made on how to design PES systems which enable small-scale farmers to participate as efficient providers of environmental services, and how to compose silvopastoral systems which maximise farmers' household welfare.

Keywords: environmental services, silvopastoral systems, transaction costs

Contact Address: Stephan Piotrowski, University of Hohenheim, Agricultural Development Theory and Policy, Schloss Osthof-Süd, 70599 Stuttgart, Germany, e-mail: spiotrow@uni-hohenheim.de

Animal Source Foods and Nutrition During Early Life

STEPHANIE GOOD[1], YOSEPH SHIFERAW[2], LENA DAVIDSSON[3], RICHARD HURRELL[1], THOMAS RANDOLPH[4]

[1]*ETH Zurich, Human Nutrition, Institute of Food Science and Nutrition, Switzerland*

[2]*International Livestock Research Institute (ILRI), Ethiopia*

[3]*International Atomic Energy Agency (IAEA), Austria*

[4]*International Livestock Research Institute (ILRI), Livestock & Human Health, Kenya*

In Ethiopia, most food supplies are derived from plant products, in particular cereals, pulses and root crops. Only 7 % of the daily energy intake comes from animal products such as milk, eggs, meat. Animal-source foods (ASF) provide not only energy and high quality protein but are also excellent sources of bioavailable micronutrients. The extremely low consumption of ASF (milk, eggs, meat, and liver) can be assumed to be a contributing factor to the poor nutrition and health of Ehiopian infants and young children.

The ongoing, longitudinal study on animal source foods and nutrition during early life in Ethiopia evaluates the possible link between livestock keeping, food intake and nutritional status of young children (6 — 18 months old) in resource poor areas. Fieldwork started in March 2005. A total of 302 low income families (with small livestock n = 108, without livestock n= 194) with 6 months old infants have been recruited into the study in the Debre Zeit area, 50 km from Addis Ababa. During the bi-monthly visits during one year information about dietary intake and — in particular - the introduction and consumption of ASF is collected and growth of the child is monitored. In parallel, information about agro-economic factors is collected to link the households' economics with the consumption of ASF. At the end of the study, a blood sample is drawn to assess the prevalence of anemia in the study population.

Preliminary data show that consumption of ASF is very low. However, cow milk had been introduced to more than half of the children by 6 months of age. The most common complementary foods are cereal based gruels, biscuits, and injera, a staple food made of fermented Teff (*eragrostis tef*).

Keywords: Agricultural economics, animal source foods, Ethiopia, infants, nutrition

Contact Address: Stephanie Good, ETH Zurich, Human Nutrition, Institute of Food Science and Nutrition, Zurich, Switzerland, e-mail: stephanie.good@ilw.agrl.ethz.ch

Development of Iron — Fortified Thai Snack Food Products Using Pork Blood as an Iron Sources

POONSUB INSUNG

Rajamangala University of Technology Srivijaya, Department of Food Technology, Nakhonsithammarat Campus„ Thailand

The research was conducted to develop the iron-riched food products using boiled pork blood (BPB) as an iron source. Pork blood was drained off by hydraulic press consisting approximately 30 % of the dry matter. Two Thai crackers, Thongmount (TM) and Phantkhript (PK) were selected as iron fortified products. Four levels of BPB in TM and PK products were 10, 20, 30 and 40 % and 25, 50, 75 and 100 %, respectively. The sensory evaluations were used as criteria for measurement the acceptability of the products. It was found that the higher BPB content, the lower acceptability of the products ($p < 0.01$). The TM and PK products at 10 % and 25 % BPB content, respectively, had the highest general appearance, colour, texture, acceptability, taste, crispy and flavor ($p < 0.01$). However, the TM and the PK products at 30 % and 75 % BPB content respectively had the overall acceptability, higher than 7 points according to the nine-point hedonic scale. Therefore, both the iron fortified products containing BPB at 30 % and 75 % BPB content, respectively used for shelf life study lasted for 0 to 45 days. The decreasing in overall acceptability of the TM products throughout the entire storage period of 45 days was lower than that of the PK products. The overall acceptability of the TM products during the 30 day-storage period was not significantly different ($p > 0.05$) from those stored at 0 and 15 days. The acceptability of the PK products at day 15 was, however, significantly different ($p < 0.01$) with that of day 0. This research result implies that using iron fortified TM products can be an alternative for solving the iron deficiency of Thai people.

Keywords: Iron-fortified products, Pork blood, Snack food, Thailand

Contact Address: Poonsub Insung, Rajamangala University of Technology Srivijaya, Department of Food Technology, Nakhonsithammarat Campus„ Thungsong - Nakhonsithammarat, 80110 Thungsong, Thailand, e-mail: plek@lycos.com

Identification Systems and Selection Criteria of Pastoral Goat Keepers in Northern Kenya- Implications for a Breeding Programme

SAMUEL MBUKU[1], ISAAC KOSGEY[1], ALEXANDER KAHI[2]
[1]*Egerton University, Animal Sciences, Kenya*
[2]*Kyoto University, Laboratory of Animal Husbandry Resources, Japan*

The objective of this study was to describe and assess the pastoral animal identification systems and selection criteria among pastoral goat keepers (Rendille and the Gabra) in Marsabit district of northern Kenya. Data on identification modes and selection criteria were collected from a total of 200 respondents (100 from each community) in a four-month field survey using semi-structured and structured questionnaires. Data were analysed through calculation of indices, which represented a weighted average of all rankings of a particular variable. Ranks were based on the first three choices of priority records and identification modes by the respondent. The index was derived as the sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for a particular variable divided by sum [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all variables in question. The most important records kept are dates of birth, castration records and entries into the flock from outside. Other records like dates of weaning, culling, performances, health and exits are also kept but ranked lower. Most of the animal identification is done through ear notching, branding and coat colour of the animals. Selection criteria with index $\geq$0.200 were considered important and included big body size (Rendille, 0.260; Gabra, 0.251) and milk yield (Rendille, 0.206) for the buck's dam. Big body size (Rendille, 0.264; Gabra, 0.245) and offspring quality (Rendille, 0.252; Gabra, 0.265) were considered important attributes for the buck's sire. Less attention was paid to individual phenotypes of the buck because selection is done at juvenile age. The results from this study imply that pedigree and performance recording has been practised through own intricate knowledge. This study showed that pastoralists have deliberate selection criteria. Productive and adaptive traits are important in the selection of breeding stock. This study provides a framework needed for the development of community-based genetic improvement programmes.

Keywords: Community-based genetic improvement programmes, goats, pastoral systems, selection criteria, tropics

Contact Address: Alexander Kahi, Kyoto University, Laboratory of Animal Husbandry Resources, Division of Applied Biosciences Graduate School of Agriculture, 606-8007 Kyoto, Japan, e-mail: kahi@kais.kyoto-u.ac.jp

Index of Authors

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

Y

Z

Abstract IDs

A