

Deutscher Tropentag 2003

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

Technological and Institutional Innovations for Sustainable Rural Development

Book of Abstracts

Editors:

C. Wollny, A. Deininger, N. Bhandari, B. Maass,
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Preface

Dear Delegates,

We extend a very warm welcome to all the delegates attending the conference ‘Deutscher Tropentag 2003’ to be held at the Georg-August-Universität Göttingen in October 2003. A very special welcome to all young scientists and students from overseas and elsewhere. Please be our guests.

The ‘Deutscher Tropentag 2003’ is the 5th annual meeting, which was preceded by conferences organized by the Humboldt Universität Berlin (1999), University of Hohenheim (2000), University of Bonn (2001) and University of Kassel-Witzenhausen (2002) in cooperation with the Association for Tropical and Subtropical Agricultural Research (ATSAF). The theme of the conference is “Technological and Institutional Innovations for Sustainable Rural Development” where research experiences on food security, natural resource management and rural development will be shared and discussed. This year we are overwhelmed by the large number of submitted contributions. This has been a challenge to the scientific committee and often decisions were difficult to make. We are proud seeing the ‘Deutscher Tropentag’ to be recognized as an international event on the agenda of the scientific community and decision makers. The programme and proceedings are published on www.tropentag.de.

The number of plenary sessions has been increased this year. There are four parallel sessions on the first and second day, and plenary sessions on the first and third day. In total, we have 16 thematic sessions and three plenary sessions. Each session begins with an invited paper and is followed by three oral presentations and several short poster presentations. Please appreciate the posters, which are on display throughout the conference. Please take your time and have a look. There are a couple of open discussion fora and meetings of associations taking place as well. Last but not least, we invite you to socialize at our conference dinner on Thursday evening.

We wish you interesting sessions, valuable discussions, and please use the opportunity to meet people from different backgrounds. We hope that you will enjoy the three-day event and leave exhausted, but enriched. To help us to improve the conference in the future we would like to receive your feedback.

We would like to thank all the DTT team members, who contributed to the planning and organization of the conference. The local organizing committee receives special thanks for having prepared this meeting. Last but not least we acknowledge the sponsors for their generous and essential support.

We wish you all a successful and enjoyable event and a safe journey back. We hope to meet all of you again at 'Deutscher Tropentag 2003', to be organized by Humboldt Universität zu Berlin.

Göttingen, 8th October 2003

Gode Gravenhorst, Director
Centre for Tropical and Subtropical
Agriculture and Forestry (CeTSAF)
Georg-August-Universität Göttingen

Clemens Wollny,
Organizing and Scientific
Committee DTT 2003
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Plenary Speeches

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Institutional Innovation, and Investment in Rural Public Goods for Development and Reduction of Poverty

JOACHIM VON BRAUN

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The institutional and political context within which the rural economy operates has changed rapidly in the past two decades. The agriculture and food system is changing from a relatively large and distinct economic sector to a more pervasive, system integrated within the global economy. In order to improve equity and efficiency, national governments must provide public goods, including internal peace, rule of law, and public investment in education, health, nutrition, and infrastructure. But a massive scaling-up of investment in enhancing productivity in rural areas of developing countries is needed, as well. The fast trend toward inequity has to be reversed because it is inefficient, unfair, and risky for societies.

Keywords: Developing countries, institutional innovation, public good

Technological and Institutional Innovations for Sustainable Rural Development

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To alleviate world poverty and environmental degradation, a new approach to agricultural research is needed. The conventional research model moving from basic to strategic to applied and adaptive research - whose products are then taken up by extension staff and disseminated, fails to address the complex local circumstances and realities of farmers and other private and public stakeholders. The new research-for-development model that is emerging focuses on enhancing the adaptive capacity of research providers and farming communities alike for 'problem-solving capability on the move'. It incorporates into the research/innovation process participatory approaches, multi-scale analysis and intervention, systems analysis and information management and impact assessment. Being more socially accountable than traditional research models, the process involves many partnerships engaging users throughout in order to identify research needs, mobilise resources, conduct the research and evaluate the outcomes.

The Africa based International Livestock Research Institute (ILRI) and its many partners conduct research at the intersection of livestock and poverty. Keeping livestock helps half a billion poor people in developing countries to secure assets, and thus provides a pathway out of poverty. This paper examines ILRI's strategic response to the changing environment in which international research is being carried out. Focal research areas and paradigms are both changing. ILRI has reorganised its research into five interlinked themes to implement a revised strategy that emphasises innovation systems, participatory research, a strengthened social science capacity, partnerships and interdisciplinary teamwork.

ILRI is committing itself to a socially distributed knowledge system, where research is conducted always within the context of application and with the imperative of poverty-alleviating knowledge products present from the start of the innovation process. To produce a stream of innovative, creative, demand-driven and competitive knowledge products has required that ILRI reorients its culture from traditional supply-driven disciplinary science to demand-driven community-based transdisciplinary scientific applications.

Keywords: Research themes, research-for-development model, transdisciplinary scientific applications

Sustainable Rural Development and the Role of Higher Education

HANNS SYLVESTER

German Academic Exchange Service (DAAD), Head of Development Co-operation Department, Germany

Thinking about the contribution of an organisation like the DAAD to a conference topic like “Technological and Institutional Innovation for sustainable Rural Development”, and thinking of rural development in developing countries or emerging societies, a linkage between Higher Education and this topic can easily be drawn. A closer look at the key words in the conference title shows different facets of Higher Education involvement taking into consideration that Higher Education is the major player in knowledge creation, knowledge transfer and knowledge application.

The phrase “Technological and Institutional Innovation” implies that there is an existing infrastructure that has to be renewed or improved. With respect to Higher Education the necessary improvement can be brought about by the universities themselves through international co-operation, which is essential for sharing the up-to-date knowledge. Only with that up-to-date knowledge the problems of rural development can be solved more rapidly and more efficiently. Especially the field of all tropical sciences show, that this co-operation benefits all parties involved and that it helps to identify strategies for research, infrastructure implementation and training measures. From the DAAD point of view it is the bi- and multilateral co-operation between scientists and departments, that is responsible for a significant “Technological and Institutional Innovation” on a very operative level in the last decades. Mutual study and research visits have made it possible to focus on problems like those of rural development, define new research areas and identify funds to finance various projects. The key word “Sustainable Development” is from the DAAD’s point of view closely related to individual training measures. We observe in all sciences a rapid fast growth of available actual scientific knowledge and new technological generations replace older ones rapidly. A sustainable effect, as suggested in the title of this conference, can only be achieved by investment in brains, an investment in qualified staff at the institutions of Higher Education, that develops innovation and finds suitable applications. Qualified staff is necessary for solving the problems of rural development, for any appropriate infrastructure implementation, and this qualified staff has to be developed and further trained on a very high level through life-long contacts with colleagues, training measures, a system of courses. The DAAD is willing to support the opportunity to take part in the necessary academic co-operation.

Keywords: Life long learning, mutual cooperation, qualification, knowledge sharing

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Viewing Multi-Functionality in Agriculture as a Tool for Development in the Latin American Tropics

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The recognition of multi-functionality in agriculture is viewed in this paper as an avenue to achieve sustainable rural development in the humid tropics. From a narrower point of view -seen from the agricultural sector – multi-functionality embeds all those functions generally attributed to the sector itself, such as commodity production, animal husbandry and of lately forestry, to the overall society. This is deemed particularly important in rural areas because it is linked to the production of goods (food, feed, timber, raw materials) and services (environmental protection, biodiversity, landscape modulation, water conservation, tourism) that sustain rural life. It is important to notice that these multiple functions attributed to agriculture could have been intended or not; or they could be permanent or just occasional. Linked to the above, another important set of functions are related to income generation and the multiplicative effects on investment and consumption. Also the demand function of agriculture is included as well as the negative side effects.

However, in a more broader sense of rural development, multi-functionality includes all other possible links to other rural economic sectors (other than agriculture), including Agribusiness, services and infrastructure. Important are here the interaction processes between the various economic rural sectors, the non-agricultural employment and income generation processes. Non-agricultural sectors demand agricultural goods and services. Multi-functionality then includes the whole rural landscape with sectors, institutions and organizations interlinked to urban centers.

Summarizing the term, it means all the commercial and non-commercial functions within rural areas and to outside spheres and especially the interaction network supporting the functions.

Keywords: Latin America, multi functionality, networking, rural development

Impacts of Multifunctionality of Livestock Keeping on Biodiversity Preservation

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The paper highlights the multifunctionality of livestock in selected Namibian and South African communities. Livestock is a crucial endowment for subsistence-oriented farmers. It affects their life in various ways and is more than a source of monetary income. This has impacts on biodiversity management as well as on development efforts.

Research in the BIOTA project has shown that population growth and biased institutional incentives, such as centralisation tendencies, increase the pressure on natural resources. All four researched rural communities in Namibia and South Africa recognise the disappearance of certain plants and animals and experience consequences for their economic and social well-being. Overgrazing is one major reason for the loss of biodiversity. The observed farmers are, however, very resistant to reduce stocking rates. Multifunctionality of livestock is one explanation for this behaviour, which has been assessed using a mix of concepts and instruments. These include economic, psychological and sociological approaches. The aim to derive a non-monetary utility function for subsistence farmers in one community has been achieved by applying the instrument of conjoint measurement. The research shows that livestock keeping is the common form of investment and risk mitigation, a means of production and transport and a source of food. It strongly affects access to social capital. The families and communities prevent livestock sales by group members through informal social sanctions. Transaction costs for substituting various livestock functions are very high for most communal farmers. Efforts to implement alternative livelihood strategies which reduce the stocking rate need to consider these complex opportunity costs of livestock reduction. Many farmers, however, recognise the environmental costs of high livestock numbers in stating that the reduction of even one animal will increase the water and fodder supply for the rest of the herd. Thus, typical common property resource problems are prevalent in the research region. In the long run livestock will fulfil its functions only if natural capital can be preserved.

Due to the multifunctionality of livestock, commercialisation and income diversification is no simple alternative to the maintenance and reestablishment of regulated common property management. Strong institutions are essential to conserve biodiversity.

Keywords: Biodiversity, common property, livestock functions, management

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Migration and Non-Agricultural Income as an Option for Sustainable Rural Development? — The Case of Zacatecas

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The agricultural sector in Mexico is still dominated by smallholders, mainly so-called Ejidatarios that work on community land. Until the debt crisis of 1982 smallholders were protected by a system of subsidies, guarantee prices and closed markets. Therefore peasants were not prepared for market competition.

As a consequence of economic reforms that were carried out during the last 20 years – such as the reduction of subsidies for agriculture and the opening of markets for agricultural products under the NAFTA regime – Mexican peasants have suffered a significant loss of income. To compensate reduced earnings from farming and livestock many families decided to send one or more members as labor migrants to the US. Zacatecas is the state that has the highest emigration ratios, more than 20 % of all households do have at least one family member.

Legal and illegal migration rose dramatically during the last two decades of the 20th century. The number of people with Mexican origin was estimated 20 million at the turn of the millennium, most of them stemming from rural areas. This has led to a negative population growth in many towns and villages.

In order to secure the substance of their families in Mexico most of these migrants send monetary transfers back home. These remittances have been rising constantly peaking at almost 10 billion US Dollar in 2001. For many households in rural Mexico remittances represent an important if not the most important share of income. In Zacatecas for 54 % of all remittance-receiving households these transfers represent the most important source of income, and for 30 % remittances are the only source of income.

The lion share of the remittances is spend on family subsistence, however significant parts are channeled into productive and community investment. The question to analyze in this paper is, whether these investments may open alternative development paths for peasants in rural Mexico or if dependency on remittances will continue.

Keywords: Mexico, non-agricultural income, rural development

Implications of Improved Oil Palm (*Elaeis guineensis*) Fruit Processing Technologies for Labour and Income among Rural Households in Imo State, Nigeria

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Oil palm (*Elaeis guineensis*) is the most important tree crop in the rural economy of the humid rainforest of eastern Nigeria. The oil is consumed as food, used domestically for industrial purposes, and was an important foreign exchange earning export. However, the processing of palm fruits to extract the oil is labour intensive. Although, in colonial times, some machines were introduced and were widely adopted, these excluded machines for crushing the fruits. This was the case until recently when locally fabricated palm fruit crushers became widely available. The aim of the study was to examine the implications of these machines for labour use and income among rural households in Imo state, Nigeria.

Data from selected palm fruit processing mills indicate enthusiastic patronage of oil mills that have introduced these machines. The machines have eliminated labour for fruit crushing, an activity which required about 10 adults working for 15 minutes. Presently, the machine crushes 60 kg of parboiled palmfruits in 6 minutes. On average 60 kg of raw fruits yielded about 20 liter of palm oil against 14 liters previously, an increase of about 50 %. This arose from the shorter processing time, and higher average temperature of crushed fruits, which aided extraction of oil.

Operators of oil pressing mills charged 4 litres of oil per 20 litres extracted as this was preferred over cash payment. Most mill operators stored the oil to sell in seasons of deficit supply and higher prices, thereby creating time utility. Average market price of palm oil fluctuated between N70/liter in surplus seasons (February - May), while highest prices are recorded between December to January (at about N110/liter)

Consequently, labour for palm processing has reduced from 150 minutes to 6 minutes for 60 kg raw fruit with machines, while output has increased by 50 %. Some problems encountered include fire wood and water scarcity.

Keywords: Improved processing technologies, Income, labour, rural households

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Options for Native Chicken Production in Northeastern Thailand

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Over the last decades, poultry-production technology in Asia has improved significantly, with rapidly increasing production. During the past 30 years, poultry egg production has increased six times and chicken meat supply has increased 14 times. Thailand is one of the world's leading countries for poultry egg and meat production, and worldwide, it is the 5th largest exporter of poultry meat. Also, the local per capita consumption of poultry meat is high, i.e., about 13.5 kg per year. Most of the meat is produced by high-performance races and hybrids; only 13 % of the meat is obtained from native chicken.

The growth of the poultry industry in Thailand is dominated by large-scale producers and their contract farmers. Due to the high cost of production inputs, such as feed and drugs, and the control of the market by the contract companies, many individual farmers could not compete with the companies and had to give up chicken-meat production. For these individual farmers, a streamlined production of native chicken could be an option for alternative income generation and for the diversification of the agricultural production base. Native chicken meat is generally considered to be of high quality, and in the larger cities in the region there is a growing market for this type of meat. However, no reliable raising systems have been developed for native chicken, which ensure a regular supply of high-quality meat to the market.

The study aims to develop options for the improvement of indigenous chicken raising systems, based on an evaluation of the agricultural production systems of small-scale farmers and a detailed investigation of the performance of native chicken in comparison to commercial breeds and hybrids.

Keywords: Hybrid chicken, native chicken, Thailand

The Village Chicken Production System and the Contribution of Chickens to Household Livelihoods in a Smallholder Farming Community of Zimbabwe

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Participatory rural appraisal (PRA) supported by checklists and intensive case studies on individual households, were carried out in three villages of Rushinga District in Zimbabwe. The chicken production system in each village was described and the problems discussed. Role of chickens in the livelihoods of households was evaluated. Flock dynamics were monitored monthly from March 2001 to February 2003. Nineteen percent of the households were headed by females who were resident on the farm. Over 80 percent of male heads of households were resident on the farm. A household was, on average, 4.8 ± 2.5 members with an arable land of approximately 2.6 ha per household. In addition to chickens, households produced maize, cotton and sunflower and kept large animals. The production systems followed were mainly low-input and smallscale, with 1 to 50 village chickens per household, reared under a scavenging system of management with sub-optimal housing, inadequate feeding and health care. The use of ethno-veterinary medicine was common in treating sick chickens. Highest flock sizes ($p < 0.05$) were observed in the hot-wet season. Over 90 percent of an average of 5.4 entries per household per month, were hatched chicks. Mortality claimed an average of 80 percent of the total exits. Chicken production potential (CPP), which defined the proportion of chickens that could be utilised by household averaged 50 percent. Chicken production efficiency (CPE), was approximately 15 percent of the CPP. Egg consumption patterns were low and similar across seasons. The low CPE could be attributed to low productivity, high transaction costs and the multi-functions of village chickens in smallholder farming communities.

Keywords: Constraints, dynamics, management, socio-economic roles, village chickens

Utilization of Photovoltaic Systems in Africa — Optimization of Grain Mill for a Rural Household Size

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Africa has poor level of mechanization, infrastructure and energy supply. Specially rural areas, where 80 % of the population is living and only 4 % of them are connected to public grid, are seriously affected by these problems. As a result the young generation is migrating to cities for better living conditions, increasing uncontrolled urbanization and unemployment while reducing agricultural productivity. Due to their scattered settlement connecting rural areas to public grid is not economical, however, decentralized power supply like photovoltaic (PV) systems is the best alternative to satisfy their energy demand. Optimising agricultural machinery for lower energy consumption (100 Wp) further encourages the utilization of PV systems. Grain milling, usually done by women and children, is one of the most drudgery and time consuming rural activity that needs optimisation.

Therefore, a project has been launched at University of Hohenheim to optimise grain mill for smaller energy consumption. Easily available materials like Corundum, Magnesium oxide, Magnesium chloride and water were used to construct the appropriate millstone. The millstone has a diameter of 150 mm and a thickness of 23 mm. It was driven using a 12 V DC motor connected to PV systems. Almost all major grains grown in Africa (maize, sorghum, barley and wheat) were used for the milling test. The parameters like millstone gap and feed rate of the grain were used for the optimisation purpose.

During the optimisation process it has been observed that reducing the gap between the millstone increases energy consumption and proportion of fine particles. Increasing the feed rate has also increased the energy requirement of the milling process. The comparison between the preference of local people in Zambia, Chad and Niger showed that the flour produced using the optimised mill is in the acceptable range for their diet. Therefore, the result indicates that the optimised grain mill whose capacity is 25–50 kg/day, is more than enough for a daily requirement (2–3 kg/day) of an average family and can be powered using a Solar Home System with two PV modules.

Keywords: Energy, grain milling, photovoltaic systems

Cost-Benefit Analysis of Eco-Labeling in the Agriculture Sector of Developing Countries in Asia

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Eco-labeling, a practice of supplying information on the environmental characteristics of a commodity, is becoming increasingly popular because of its potential to achieve environmental goals through a market-based approach. Although it is more widely used in manufactured products, it is slowly gaining ground in the agricultural sector. In this sector, eco-labeling includes certified organic farming in as much as it involves environment-friendly practices, such as less intensive use of land and soil fertility-improving techniques that do not involve the use of chemical elements. While conversion from conventional to organic farming is deemed environmentally-beneficial, an extensive assessment to determine its costs and benefits for the developing countries is still lacking. It should be noted that based on a very few non-empirical studies, costs could be high due to certification and possible yield reduction. This study is deemed necessary and relevant especially since certified organic farming in the developing countries is only in its infancy stage, and done mostly to access export market of developed countries. This study could help the governments (1) assess the overall efficiency of organic farming both on economic and environmental grounds; and (2) address constraints and opportunities of organic farming.

The study aims to assess the overall costs and benefits of certified organic farming in Asian developing countries, specifically Thailand and the Philippines. Motivation for this study is based on the increasing trend in the demand for organic products. To achieve this objective, a structured questionnaire was prepared before a survey is conducted for organic farmers of one major export organic commodity, that is, rice for Thailand and banana for Philippines. Using the data collected, analysis was undertaken by comparing the costs and benefits for both the organic farmers and conventional farmers. Results of the study would show not only the financial costs and benefits but environmental and health as well. Relevant policy implications are derived with regard to needed interventions by the government as well as other concerned international organizations, e.g. the World Trade Organization (WTO), considering that there are still gray areas in the use and implementation of eco-labeling in international trade.

Keywords: Benefits and costs analysis, eco-labeling, environmental labeling, organic agriculture

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Small Ruminants and Livelihood of Poor Rural People in Southern Benin

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The majority of the human population in Southern Benin live in rural area, where they eke out their living from very small plots of land. They have very limited regular off-farm opportunities and lack access to credit from formal source. At the household level, they are also faced with consumption and income shocks. That leads to low investment in their agricultural activities, and consequently, to land degradation, to low productivity and income, causing a vicious circle of poverty. Previous studies indicated that small ruminants are raised in many households and this despite the presence of trypanosomes, which are a serious constraint to the development of livestock production. Biological, cultural and environmental arguments have been advanced for conserving these local genetic resources. However, the question is whether the conservation option fits with keeper's perspective. There is thus a need to better understand the roles of these animal genetic resources in the livelihood strategies of people that keep them. Between November 2001 and April 2002, a field survey was conducted in 240 randomly chosen rural households. The results indicate that 78 % of households keep small ruminants. Within household, animals are individually owned and managed by household's members. The characterisation of people that are more likely to be owners shows that they have no access to credit from formal source, are relatively young and have no regular off-farm employment. More than 85 % of the off-takes are sold. The motivation for the sale are mainly to purchase foodstuffs and clothes (36 %), to finance farm and other subsidiary activities (22 %) and to pay school and training fees for children (12 %). Through kinship networks termed as care taking, small ruminants are also used to build social capital. Despite considerable variation between flocks, gross margin per annualised breeding female reaches 56,300 FCFA^a for sheep and 38,600 for goats. Giving that the absolute poverty line in the area is estimated to be 56,000 FCFA, keeping two to three breeding females of goats and/or sheep mitigates rural poverty. Improving flock productivity would be one option to conserve the small ruminant genetic resource through intensification of utilisation.

^a655 FCFA = 1 €

Keywords: Small ruminants, animal genetic resources, rural people, poverty, livelihood, Southern Benin

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Digestibility and Utilization of Soy Sauce Residue as Dairy Cow Feed

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The study was conducted to determine the rumen degradability and in vitro digestibility of soy sauce residue (SSR). Soya sauce residue was incorporated at 0, 10, 20 and 30 % of the total rations and offered to four rumen fistulated crossbred Thai Indigenous × Holstein Friesian cattle of average 380 ± 74 kg in a Latin Square Design study. Rumen degradation of SSR was determined using the nylon bag technique and the digestibility using MENKE in vitro gas technique. The SSR had 82.37 % DM and the nutrient profile in percent of dry matter (DM) was: 85.91 % organic matter (OM), 22.10 % crude protein (CP), 20.08 % ether extract (EE), 11.89 % crude fibre (CF), 45.32 % neutral detergent fibre (NDF) and 20.84 % acid detergent fibre (ADF). The constants for SSR degradation were: for the rapidly soluble fraction (**a**): 20.8 %, for the fraction that will be degraded with time (**b**): 67.2 % and for the rate of degradation of the b fraction (**c**): 0.0306 h^{-1} . Effective degradation of DM at 0.05 h^{-1} flow rate was 79.4 %. The effective degradation of DM and CP of SSR in the 30 % SSR diets were significantly ($p < 0.05$) higher than in 0, 10 and 20 % SSR diets. DM intake, digestible DM, growth rate index values estimated using the nylon bag technique were significantly ($p < 0.05$) different from the other treatments and ranked least. The predicted values of OM digestibility, Metabolisable energy, Net energy for lactation, DM intake, digestible dry matter and growth rate using the MENKE in vitro gas technique on the 10 % dietary treatment were significantly ($p < 0.05$) higher than on the other diets. In both the nylon bag and gas test methods there was an evident curvilinear response. There is potential for the use of SSR in dairy cattle diets and in this study 10 % inclusion was optimum.

Keywords: Dairy cow, digestibility, soy sauce residue

Better Use of Small Timber and Wood Residues for Sustainable Rural Development

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In many tropical regions there is an urgent need for afforestation for environmental reasons. Denuded mountains cause floods and droughts, bare soils in dry plains lead to desertification and sand storms. Just to know about these problems is often not sufficient to motivate people to plant trees. Basic preconditions for investments in wood production are capital and the perspective of a satisfying return of the investment. Therefore, if you want to promote afforestations it is necessary to find possibilities for an early income from the stocked area. A well-known example is the cultivation of annual crops during the first years of tree growth. But when the canopy is closed only fruit trees or timber from thinning can create some cash.

Thinning of young stands only provide small timber which traditionally is being used for poles and fuelwood. In this presentation it will be analysed which possibilities there are to make more money from tiny trunks. Due to the lack of investment capital and the remoteness of many areas to become afforested, paper mills and big plants for wood composites are not being considered here.

As an alternative the following technologies with a potential for rural tropical areas are being presented:

- Small diameter round wood for construction: Newly developed connection technologies provide innovative applications for roundwood for 3 to 20 cm diameter.
- Composite beams: The production of engineered wood is increasingly used to make money from small and low-value timber.
- Cement bonded boards: Boards made from wood wool and cement are extremely durable, easily workable and resistant to water, rot, fire and termites. Plants for prefabricated houses based on such boards were built in several tropical countries.
- Fungi production from wood residues: A traditional form of non-timber forest products needs further investigation.

Keywords: Afforestations, cement bonded boards, composite beams, edible fungi, round wood, small timber, thinning

Gender Impact on Living Standard — A Case Study of Druze Farming Systems in Lebanon

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In Lebanon, most investments are channelled into the sectors of trade and financial services, while agriculture and industry are largely neglected. As a consequence the agricultural sector suffers from persistent structural problems, the gap between rural and urban areas is continuously widening and especially young people are migrating to the cities in search for employment. Women play a crucial role as producers of food, managers of natural resources and executors of household food security. Nevertheless, they face numerous cultural and religious constraints and their role as a human resource is largely undervalued due to the lack of gender desegregated data.

A comparative analysis of 30 small-scale farms with male and female household heads in 5 Druze villages in the Chouf mountains, allowed for the specification of the problems of local farming systems and their general causes, the contribution of women to income generating activities and their constraints. It also yielded information on differences in living standard, linkages within the rural community, strategies of successful and less successful farmers, interactions between different activities and their effects on the families socio-economic situation under special consideration of gender aspects.

The results indicate that major constraints for both men and women are limited access to resources, specifically high costs of inputs, low prices of outputs and lack of access to credit and marketing facilities. Nevertheless, female-headed households are significantly more affected by poverty since women face numerous additional constraints, like lack of land title, use of very low levels of technology and restricted mobility due to prevailing socio-cultural norms. Farms with higher economic success have better access to assets, specifically cash (pensions, liquid assets like livestock), and human capital (education, involvement and recognition of women). They have more choice and flexibility in the use of their resources, (alternative sources of income, diversified farming systems), and possess a greater ability to cope with structural problems and seasonal fluctuations.

Keywords: Farming systems, gender, Lebanon, living standard

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Tourism-Induced Labour Mobility in Tanzania — Case Study Zanzibar

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Tanzania has seen a remarkable increase in tourist arrivals in recent years and particularly Zanzibar has already evolved into a mass tourism destination. Such a development of a modern industry obviously leads to a substantial demand for labour. Labour requirements are met by the huge labour surplus among the local population. But there are also migrants from the mainland and even from abroad working in the tourism industry in Zanzibar. However considering the high unemployment rates on the island and the rapid population growth rate of about 3 % p.a., labour supply still seems to be greater than demand.

The aim of this study is to make a contribution to the discussion concerning the effects on tourism in developing countries, focusing on labour mobility, which results from the expanding tourism industry. Therefore a survey has been conducted to investigate the preconditions, structures and consequences of tourism-induced labour mobility in Zanzibar, which occurs in spatial mobility as well as in social mobility. The focus of the survey is the informal tourism sector (ITS), which can be seen as the most important labour market for migrants. The major aspects to be analysed are demographic and socio economic characteristics of the participants, who perform the tourism induced labour mobility process. Furthermore push and pull factors, scale and intensity of tourism-induced migration in the spatial-time dimension have been emphasised.

The growing attractiveness of the tourism labour market in Zanzibar has been underlined by the analysis of the collected data. It turned out that mostly migrant workers from the mainland of Tanzania and the neighbouring country Kenya benefit, while the local employees are underrepresented both in the formal and in the informal tourism sector. This phenomenon results in a rising conflict potentially between the migrant workers and the indigenous population, which could lead to a backward developing process for the island and for the whole country in the end. To avoid such negative development, Zanzibarian employees should be enabled to compete with the better qualified immigrant labourers.

Keywords: Developing countries, labour mobility, migration, Tanzania, tourism, Zanzibar

Preliminary Results of the Risk Assessment in Pigs Production and Pigs Processing in Small-Scale Enterprises in Vietnam

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In Vietnam, there about 90 % of animal food production originates from small-scale farms and manufactures. As especially pork is favourable subject of choice in eating habits of Vietnamese people, preferably, except of soup, in not “well done” way of cooking, hazard of food borne diseases is expected. Therefore the first study of “risk analysis” both at farms and small meat processing plants was initiated, with the aim to obtain information for “risk management”. The first investigations of Critical Control Points were carried with the aim to localize the main sources of hazards in the course of breeding and finishing of pigs. The sporadic outbreaks of some epizootic diseases can cause devastating losses to smallholder pigs’ farm. During rainy season antibiotics (tetracycline) as respiratory disease treatment and preventive measure are used, without following recommended withdrawal period prior to slaughter. Amongst diseases with the highest incidence, those caused by mineral and vitamin deficiency are observed. Outbreaks of swine fever by smallholder farmers are often not reported, therefore actual epizootic situation is not precisely known. It may also be the reason, why the above discus occurs despite the use of vaccination in farms.

Hygienical assessment of feed mills also was included, both from the part of raw materials and CCPs in the course of processing, possibility of recontamination included. Hazard in pigs transport to the slaughterhouses was assessed, taking into consideration procedure of veterinary health status certification of animals for slaughter at small-scale abattoirs, from the possibility of HACCP system implementation.

The ways of pigs carcasses handling, wholesale conditions and their transport by the retailers with the observance of valid Veterinary Care Act were confronted. The lack of a cold chain impedes the greater development of an efficient animal slaughtering and meat processing industry. Without a cold distribution chain, meat cannot be transported over large distances from inexpensive surplus areas to expensive deficit areas in Vietnam. In addition, the absence of an effective cold chain in storage and distribution of meat is causing rapid increase of saprophytic and even pathogenic microorganisms counts and poor hygienic conditions of pork meat.

Keywords: Pigs production, risk analysis, risk assessment, small-scale farms, small-scale processing plants, Vietnam

Alternatives for the Transformation of Drug Production Areas in Bolivia — Results from the Region Chapare for Farming Systems

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The region of Chapare in Bolivia is classified as “humid sub tropic”, where 35,000 families live. Ninety two percent of inhabitants are agriculturists. Until now, 93 % of the coca cultivation (*Erythroxylon coca* L.) has been eradicated leading to serious social, economic and ecological problems.

Based on cultural concepts of the population and their commercial interests, the most important agricultural crops grown in Chapare region are Citrus and Banana, which occupy 20,8 % and 18,8 % of the total area, respectively. Both crops are intended for the market and therefore play an important role in the economy of the region. Cassava (7,3 %) and rice (7,2 %) are cultivated for growers’ consumption and their self-sufficiency. The average agricultural land possessed by a family amounts to 10.4 ha, but, due to lack of capital and high labour cost, only 2.6 ha is cultivated. The remaining (74 %) of the land is under forests and fallow. Generally, seeds of bad quality are frequently used. Intensive use of agri-chemicals in terms of amounts and levels is a common practice in the area. The crops are raised as small households in small farms and the labor force engaged in crop husbandry and various agricultural activities originates from the local families living in the surroundings of the fields. The family from which workers come earns an approximate disposition of 460 daily-wage/year per hectare in average.

Altogether 65 % belongs to the Subsistence economy. They have a capacity on the average for investment of 400–800 US\$/ha (in 89 % of the cases). The alternative cultivation products (banana, pepper, maracuya, ananas and palmito) result in small income and yield 600 to 2400 US\$, which is a third to a sixth of hectare proceeds with coca. The initial investments for alternative crops are as high as \$ 1800–5000 provided that proper management and good technical knowledge is made available. Actually the alternative crops do not provide a real opportunity for the families of this region. Investigation should be focused on other crop alternatives to obtain sustainable production resulting in better agricultural industrialization, to reinforce the national market. The social aspect of the present problem needs more attention.

Keywords: Farming systems, coca, alternative crops, drugs

Transaction Cost Economics of Sugar Industry in East Java, Indonesia — A Comparative Study

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In 1920's decade, Indonesia was recognized as one of the great sugar cane-producing countries in the world. Sugar cane is mostly grown in East Java Province. This area contributes about 70 percent to national sugar production. However, the performance of sugar industry in East Java during the last decade has declined, which is shown in decreasing volume of production and increasing sugar price. In effect, since the last ten years, Indonesia must import sugar due to the lack of domestic supply. Some analyses concluded that the decrease in production results from old milling machine. Another analysis inferred that the sugar cane farmers shift to other plants due to the long procedure in sugar production. The findings, of course, provided the description of the cause of the deterioration of sugar industry in East Java.

Nevertheless, a deeper investigation for the cause of decreasing production and increasing price of sugar should be made again. This study will utilize the analysis of transaction costs to identify the problems. It is expected that the institutional setting, both institutional environment and institutional arrangement at sugar industry cause high transaction costs, which shift farmers' decision to other plants and lead the sugar factory to be in high-cost economy situation. The transaction costs emerge due to some factors, such as rent-seekers, inefficient milling process, and weak enforcement law. In details, this research will empirically compare the transaction costs between state-owned and private-owned sugar factories; and credit-sugar cane farmers with self-sufficient (non-credit) sugar cane farmers. The comparison will provide the whole description of the factors causing the transaction costs at the sugar industry.

Keywords: East Java, Indonesia, institutional arrangement, institutional environment, sugar industry, transaction costs

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Back on the Agenda: Extension and its Institutional Linkages — Some Personal Observations on the Re-discovery of a Key Player

UWE JENS NAGEL

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While there is wide agreement on the need to address global poverty, food security, and environmental problems one notes a visible reluctance to commit the corresponding resources. This is particularly true for the field of extension. Agricultural research, on the other hand, has not suffered similar financial or status losses. Methodologically, scientifically, and organisationally the research system has been extremely innovative during the last two decades. More recently, extension has received renewed interest. In this paper, the ongoing discussion — rather undogmatic and highly cosmopolitan — is analysed and commented upon.

Questions of finance, efficiency, effectiveness as well as the delivery of public and private goods are discussed by looking at challenges, new organisational or institutional arrangements and the corresponding linkages and players.

The poverty issue is discussed as the single most important challenge. The formal incorporation of poverty alleviation into the goals of the CGIAR was of immediate practical importance. Very recently the question of pro-poor extension activities has again received increased attention. Policy reforms are to be expected which will concern a differentiation of target groups, organisations, and innovations.

The debate on organisational questions has gone beyond the simple public vs. private extension issue. There is growing agreement that organisational pluralism is called for. Funding of advisory work and delivery of innovative knowledge must not necessarily be in one hand. The overall system can accommodate different organisational and institutional models.

Not all linkage problems that need to be solved are new: The lack of strong linkages between the sources of innovative knowledge and the dissemination system is still a widespread phenomenon. New and important actors are playing an active part in the Agricultural Knowledge System. The role of consumers and environmentalists with regard to priority setting and communication is a challenging research topic.

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Challenges and Policy Options for Sustainable Rural Development — Future Development of a Participatory Extension Approach in Myanmar

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The participatory extension approach in Myanmar is in the very preliminary stages of the development by international NGOs and United Nations organizations. Although its present status in Myanmar is very small, a growing interest has been noticed among farmers, extension agents, NGOs and some quarters of the government. NGOs are putting efforts into the development of participatory extension approaches in many developing countries. The main objectives of this paper are to explore the organization of current agricultural extension agents, and to suggest a suitable network among governmental and non-governmental organisations for the future development of a participatory extension approach in the Myanmar Agriculture Service. The perceptions of agents regarding the practising extension approaches, extension methods and awareness and attitudes of agents towards the participatory extension approach were identified through personal interviews with 60 extension agents, conducted from January to April 2001 in Myanmar. The research findings indicated that the current extension approaches practised in Myanmar are the selective concentrative strategy approach and the training and visit approach. Both of these are top-down approaches and the major aim is to transfer the technology. The organizational framework did not provide for decision-making from below and consequently, left little or no room for participation of all members of the extension system. Approximately 83 % of the respondents have an awareness of the new participatory extension approach and they have acquired this knowledge mainly from UNDP and NGOs projects in Myanmar. Some respondents have been involved in participatory workshops provided by the UNDP and NGOs. Responses of extension agents showed that they are very interested to implement the participatory approach in agricultural extension services. For the sustainable agriculture and rural development in Myanmar, agricultural extension services will play in the most important role. In order to promote the development of agricultural extension services in Myanmar, the effective institutional linkages between the governmental and non-governmental organizations will be required. With this in mind a new forum for participatory extension movement in Myanmar is proposed in this paper.

Keywords: Extension organization, participatory approach, Myanmar

Market Access and Plant Productivity in Indian Agriculture

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Agricultural markets have been found to significantly affect aggregate productivity. Several studies covering a wide range of countries and agroclimatic conditions have quantified direct (specialization) and indirect (intensification) effects of market access on farms' productivity, using data from one shot surveys (cross sectional data collected from farms randomly selected in villages purposively chosen at different distances from input/output markets). These studies show significant relationships of productivity increasing with better market access. However, the causality cannot be proven. Markets might have developed in response to better productivity.

A data set from India offers the opportunity for studying agricultural change over a long time and across a wide diversity of districts. Statistical information available from 1966 to 1994 (29 years) for a total of 235 districts provides a time-series-cross-section data set containing 6815 observations. The observations include information for every district on area and production of 22 crops (food crops, oil seeds, commercial crops, pulses) and their prices; also data on inputs used (fertilizer, high yielding varieties) resources (irrigated area, farm size, credit, literacy, population) and market access (densities of roads and markets) are available. Out of 235 districts 12 highly populated urban agglomerations were distinguished as deficit districts and the remaining 223 districts were called surplus districts.

These data allow testing several hypotheses on market access affecting productivity with especially surplus districts. The data are tested with a model estimating simultaneously a system of equations (3SLS) expressing total productivity as a function of market access, inputs and resources; and also inputs as a function of market access, productivity and resources.

Results indicate that the lag with which productivity responds to market access is around five years.

Keywords: Market access, simultaneous equations system, aggregate productivity

Redesigning Public Agricultural Research and Development in Brazil

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Agricultural research and development (R&D) has played an important and increasing role in the course of agricultural development all over the world. In Brazil public agricultural R&D was started with the creation of Embrapa at the beginning of the 1970s. Since then, Embrapa's contribution to agricultural R&D for tropical regions became well known worldwide. However, in the last decade, Embrapa's R&D focused mainly on agribusiness, neglecting the fact that other groups of rural society, like family farmers and peasants, who are responsible for a significant part of food production, would have different demands than that of large-scale commercial production units. The governmental change which took place January 2003 represents a reorientation of the whole economy: from a neoclassical model to a social market economy. After decades of R&D on the development on the "Green Revolution-Model" now Embrapa is challenged to open the focus of its work to give answers for demands coming from all groups of the Brazilian society involved in agricultural production, like tenants, peasants, family farmers and large scale commercial farms as well as to provide solutions to increase the workability of whole production chains of agricultural products. Therefore Embrapa's R&D agenda is being redesigned to match better the upcoming challenges, and will concentrate on ten priorities: 1) to prioritize technology transfer to family farms; 2) to consider more environmental questions in research; 3) to support the social programs of the government; 4) to assimilate the concept of multifunctionality of rural areas; 5) to contribute to improve the Brazilian agribusiness; 6) to improve capillarity and social control of R&D activities; 7) to build up institutional arrangements to support spatial development; 8) to develop and to validate practices of organic farming and agroecology; 9) to generate information and scientific results on impacts of genetic modified organisms on environment and human health; and 10) to consolidate the actuation of Embrapa as an 'arm' of the Ministry of Agriculture, Livestock and Food Supply together with the Ministries of Agrarian Development, Science and Technology, Environment, and specially, with the Extraordinary Ministry of Food Security and the Fight Against Hunger.

Keywords: Agricultural research policy, Brazil, EMBRAPA

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The Impact of Agricultural Development on Agricultural Employment and Rural Labour Markets — Evidence from Western Africa and Eastern Europe

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Agricultural employment is the decisive factor for rural well-being in developing countries as well as in many eastern European transition countries. This is because, differently from Western Europe, there are, in many regions, almost no other employment opportunities than farming. Therefore, the decrease of agricultural employment opportunities yields social and economic distress, especially for the most vulnerable, the landless and the small scale farmers who have to seek supplementary income from working casually on other farms.

But agricultural employment is subject to many factors. Labour hiring is strongly affected by short term productivity developments. Structural adjustment in the agricultural sector decreases labour by substituting it with capital.

This contribution analyses the effects of agricultural development on agricultural labour markets and thus on rural employment. It gives evidence from two regions that may seem different at first glance, but show surprising similarities: Eastern Europe and Western Africa, especially Niger. Using the method of calculating short term and long term labour demand elasticity for the agricultural sector, effects of both short term distortions (e.g. price or yield declines) and long term adjustments are assessed. For both regions, it can be shown that short term distortions in agricultural productivity, mainly caused by price decline, lead to a sharp decrease in hired labour employment. The following structural adjustment mostly leads to a substitution of labour by capital. Consequently, when the initial productivity losses are compensated, less labour than before is employed at the same productivity level so that the net effect is a decline in agricultural employment over time.

Based on this knowledge, recommendations are given for both Eastern Europe and West Africa. It is most important to establish a balanced structural policy that aims at both improving agricultural efficiency and creating off-farm labour, e.g. in the downstream sector.

Keywords: Rural labour markets, rural development, Africa, Eastern Europe, structural policies

Marketing of Alternative Products of the Tropics of Cochabamba (Bolivia) as Substitutes for the Coca-Cultivation

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Since the beginning of the 1980s in the tropics of Cochabamba, Bolivia, started a fast spread of “illegal” coca-cultivation. That’s why, in the middle of the 1980s, the government started a program called “Alternative Development”. The objective of this program was to fight against drug-production and drug-trade and gradually reduce the coca-plantation area. To promote the substitution of coca-plantations, the government had to offer alternative crops to the farmers. Unfortunately the program was focused mainly on aspects of production and not on aspects of marketing. Now, that the production of alternative crops has increased, farmers recognize that the marketing of their alternative crops is a major problem. If the marketing conditions of alternative crops will not improve in the near future, farmers will start with the cultivation of coca-plants again. This would destroy the partial success of the coca-substitution-program and would stop the necessary development of the whole region. This survey will identify the most important marketing problems of alternative crops. This can be a starting point to improve the complete marketing chain. The current marketing barriers can be located at different points between production and consumption. A complete investigation of the whole marketing chain of alternative crops is difficult to realize. For this reason, the investigation will focus on areas with a potential high impact. After a preliminary survey the following main constraints were identified: production conditions of different alternative products; trade conditions between different market participants; characteristics of supply and demand; market infrastructure; farmer’s organization to market their products; promotion activities for alternative products and market information. For the survey, primary as well as secondary data was collected in Bolivia. Primary data was collected through interviews with farmers and experts. Since the data has not yet been completely evaluated, the results of the current survey are not yet available.

Keywords: Alternative development, coca-cultivation, marketing chain, marketing of alternative products

Asset Specificity and Organizational Arrangements — The Case of Introducing Specified Technology in a Rural Area of Brazil

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Subject of this analysis is the co-operation between researchers and peasant landowners introducing an innovative technology of tractor-driven bush choppers in Brazil. This socioeconomic project (ZEF and EMBRAPA) is located in Cumarú, Munizip Igarapé-Açu. A project like this is highly depending on the right choice of organisational arrangements to ensure the consent of both groups concerned, agrarian scientists on the one hand, peasant landowners on the other hand. The scientists are most interested in testing the efficiency of new machinery in “secondary” forests, the peasant landowners want to maximise their profits. To secure their goals both groups have agreed on an informal contract to form this co-operation. They have chosen a “hybrid” organisational form instead of a “market-orientated” or a “hierarchical” organisational form. The co-operation uses newly developed tractor driven bush choppers that are especially designed to be used in secondary forest regions like Cumarú. Using these choppers is not only a fire-free technology, it also insures a sustainable development and an alternative to the traditional method of slashing and burning soil for shifting cultivation in the Eastern Amazon region. Introducing highly specified bush choppers shows a high degree of specificity.

This paper uses the “new institutional economics” theory with special attention to the “transaction costs” in order to support the analysis in agrarian research. Asset specificity refers to the relative lack of transferability of assets intended for use in a given transaction in comparison to other uses. Using highly specific assets reduces costs. In the analysis of these assets it is important to keep in mind, that investments in highly specified machinery have little value beyond their designated use. For the analysis of this context “site specificity” and “physical asset specificity” are the most important parameters.

By analysing asset specificity this study helps to find the best possible organizational arrangement for a given co-operation between researchers and peasant landowners in the rural Eastern Amazon region of Brazil.

Keywords: Asset specificity, organizational arrangements, new institutional economics, transaction costs

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Toward a Sustainable Development in Agriculture — An Analysis of Training Needs for Potential Extension Agents in Myanmar

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Determination of training and development for personnel in any organization is a challenging task. Although the Agricultural University and Institutes provide courses on basic sciences and various aspects of agriculture in their curriculum, they only teach agricultural extension subjects during the students' final year of study. Many of the students that graduate from the Agricultural University and Institutes become extension agents employed by Myanmar Agriculture Service. The Central Agricultural Research and Training Centre carries out the pre-service training program that provides only for potential extension agents before they are going to work at farmers' fields and a number of in-service training for field extension agents. However, most of the training was crop production oriented and training in extension education has been scarce. Much of the training emphasized on new technical knowledge and on one-way communication skills needed for the transfer of technology and there was a lack of training needs analysis. These training institutions have a vital role to play in the sustainable development of agriculture in Myanmar. The purpose of this paper is to explore how the agricultural training program in Myanmar could be improved by analysing the perceptions of experienced extension agents towards the training needs for potential agents who are recent graduates from the agricultural University and Institutes. The questionnaire survey has been done with 70 extension agents. The research findings indicated that the following training topics were perceived to be required for potential extension agents. The importance of needs in order of priority were extension program planning, educational process and human development, research methods and evaluation, agricultural extension philosophy, organization and administration, communication in extension and sociological factors. Agents responded their perceptions based on their experiences in performing extension activities at farmers' fields, knowledge that they learned in University or Institutes and pre-service as well as in-service training. These training topics should be emphasized in the pre-service training program. Many of the social science skills are lacking in the agricultural graduates working as extension agents in the agricultural extension division. To improve performance and increase the motivation and job satisfaction of extension agents, a greater need for continuous training and guidance in respect to extension methods and content is required.

Keywords: Agricultural extension agents, Myanmar, training

Comparative Advantage and Export Potential of Thai Lychees

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The lychee market is dominated by Asian countries in terms of production, consumption and trade. Thailand is the world's fourth largest lychee producer with 85,000 tons of annual production. In recent years lychee production in Thailand is facing heavy competition within the country, competing for land against other perennial crops, and competing for demand against other Asian countries in particular China. Thus, the objective of this study is to explore to which extent Thai lychee production is internationally competitive and which potential there is for world trade of lychee with a particular focus on Thailand.

Lychees are produced in the northern region of the country predominantly by small-scale farm households. Many farmers have reduced lychee production and shifted to other perennial crops such as oranges mainly to avoid risks due to yield and price fluctuations. However, lychee is a horticultural crop with an increasing demand domestically, within Asia and in Europe, North America and the Middle East. The discrepancy between the production trend in Thailand and the demand trends calls for a closer look to determine if Thailand has a comparative advantage for lychee production and the potential of exporting lychee.

The study has two parts; the first is an analysis of the comparative advantage and the second presents estimates of the potential of the export market for Thailand. The domestic resource cost (DRC) method is used to determine comparative advantage of lychee in Thailand. The DRC ratio is a measure of the cost of production when prices are adjusted for taxes and subsidies and resources are valued in alternative uses. The estimation of supply and demand elasticities along with a descriptive analysis will be used to estimate the potential of the international lychee market.

The results of this study show that Thailand has a comparative advantage for producing lychee for the world market but advantages vary across the region. The analysis of the international market indicates that there is a growing demand market particularly in Europe and in North America.

Keywords: Comparative advantage, lychee market

Fund System Transformation and Policy Options for Agricultural Research in China — Case Study on Fund System for Breeding

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The support for agricultural research is being strengthened throughout the world constantly, and the key role of agricultural research to agricultural development is more and more important. In China, the total fund amount for agricultural research is also increased at all times. Nevertheless, there are some problems about the fund system, and the ultimate cause of the problems is that the system of fund raising and allocation is not rational. The system should be reformed and transformed to enforce fund raising and to enhance fund use efficiency.

Since the 1950's many scholars outside China have addressed study on agricultural research. In China, the history is shorter, the work of qualitative analyses was more than of quantitative, and the whole work has some shortages, such as: the mechanism of fund raising action have been rarely analyzed; the profit research fund from private sector has rarely been studied; the exterior conditions of research fund have rarely been evaluated; it lacks research on mutual relation and mutual action rules among fund raising structure, allocation structure, organization structure and market structure.

In this research topic the above issues will be studied to provide schemes and policy suggestions for the transformation of agricultural research fund system for China and further as reference for other developing countries. The structure change and common rules of agricultural research fund will be analyzed with case study on fund system for breeding. The results of research will be divided into commonwealt results and profit results, and the fund raising actions of public sector for commonweal results and of private sector for profit results will be analyzed. Hereby, this project has important theoretical value and practical significance

Keywords: Fund system transformation, policy options, agricultural research

Reinforcing the Agricultural Research and Extension Services in West Africa — Case of Rice

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Stakeholders of the agricultural production system in West Africa have expressed the need for a more efficient extension system. Since producers are cash poor farmers an innovative service must be implemented in a way that the farmers as well as other stakeholders can contribute and feel the right to demand this service plus the responsibility to make it work. In Benin and Nigeria, research and extension services have received technical and financial support but its sustainability is still questioned. The main goal of this research is to study the feasibility and framework for an innovative research-extension support system, in order to boost the dissemination of technologies in a more cost efficient and sustainable way through empowerment of farmers, enhanced competition and increased accountability of stakeholders. The proposed system is based on the concept of knowledge broker (KB) and encompasses both participatory technology development and financial participation. The study area includes small villages located in the states of Ogun, Kogi and Ebonyi in Nigeria and the sub prefectures of Dassa and Glazoue in Benin. The Participatory Technology Development (PTD) project has completed its first 3-years phase and a second phase is envisaged. During the first phase some tools have been used to developed the knowledge base that will allow the implementation of the KB concept: **a)** crop production function, to assess the variability of factors affecting yields in farmers' fields; **b)** production system analysis to asses the effect of heterogeneity in resource base and input use across the regions; and **c)** stakeholder and institutional analysis to evaluate human and physical resources as well as technical, financial and institutional constraints to KB. During the second phase the KB concept will be implemented.

Keywords: Financial participation for extension services, institutional innovation, knowledge broker, participatory technology development

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PROCORDEL — A Regional Research Network for Livestock Development in West Africa

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The EU-funded Programme Concerté Recherche-Développement sur l'élevage en Afrique de l'Ouest (PROCORDEL) has been conceived in 2000 with the objective to provide livestock owners in West Africa with improved and/or new technologies to increase livestock production and hence impact on rural livelihoods and food security. The underlying principle is the reinforcement and expansion of networks between research systems, such as the National Agricultural Research Systems (NARS) and their partners, sub-regional Research Institutions and regional research bodies such as the Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricole (CORAF). The assistance by IARIs and other donors forms part of the concept to overcome the well known constraints to research in isolation, such as limited technical and human capacity and duplication.

The project links these institutions in 13 West African countries and as such touches on almost all key stakeholders in livestock-based agricultural development. Principal fields of research are Animal Health (diagnostics, epidemiology, disease risk assessment, meat and milk hygiene), Animal Production (breeding, feeding, reproduction) and Capacity building (training at technical, professional and post-graduate level). Technical research is accompanied by socio-economic investigations that are designed to put research results into the macro- and micro economic context. Activities are mainly implemented by the NARS of the partner countries, with the support and scientific guidance of the two sub-regional Research Centres, the International Trypanotolerance Centre (ITC) in the Gambia, and the Centre international de recherche-développement sur l'élevage en zone sub-humide (CIRDES) in Burkina Faso, with input from the International Livestock Research Institute (ILRI) in socio-economics and the Centre international de recherche agronomique pour le développement (CIRAD) for provision of technical assistance. It operates under the auspices of CORAF.

This paper describes the overall project objectives, and more specifically the approach to networking in research and key outputs of the part of the project implemented by ITC in the Gambia, Senegal, Guinea, Guinea Bissau and Liberia.

Keywords: Animal health, animal production, NARS, Research and Development, research networks, socio-economics, West Africa

Reducing Rural Poverty at the Micro Level — A Case Study of the Province of Azuay / Ecuador

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Poverty is mainly a rural problem because the rural poor often do not profit from macroeconomic poverty fighting measures. Therefore it is necessary to conceptualise procedures that are directly related to the households of the needy. These measures are regarded as poverty fighting at the micro level. They mainly aim to strengthen the productive abilities of the poor.

The first step for the sustainable promotion of the poor's productive abilities is to identify a target group. For this case study the target group consists of small farmers from 16 communities of a highland region in Ecuador, which are located around the protected forest Aguarongo in the province of Azuay.

Furthermore, a detailed knowledge of the small farmers situation and the causes of their poverty is prerequisite for conceptualising measures. Therefore, a socio-economic survey was carried out with following topics: size and structure of the household; education; landed property; agricultural production; other activities; migration; monthly income; markets; and credits.

The results of the interviews revealed that the majority of the population lives in extreme poverty. Moreover, the results gave a detailed insight into the small farmers situation and pointed out the causes of their poverty. For example, due to the prevalent bad conditions (erosion, hardly any irrigation) and few landed property, they can carry out their farming activities only insufficiently and therefore, they are hardly able to secure their subsistence level.

Furthermore, due to their poverty, farmers are overusing the soil and cutting down the forest Aguarongo, although the Aguarongo is the only water catchments area of the region. If the degradation of the area is progressing too much, then the colonisation of the area cannot be secured any more because of lacking drinking water. Therefore, poverty fighting measures are essential. They have to be conceptualised in a way that increases the income of smallholder farmers as well as secures the sustainable conservation of the study area. Hereby, training of the farmers and the integration of micro-finance organisation into the study area play a crucial role.

Keywords: Causes of poverty, micro-finance organisation, productive abilities, small farmers, conservation, training

Determinant of Households Access to Credit in Rural Areas of Central Sulawesi Province Indonesia

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Credit plays the important role in the development of agriculture, particularly in rural areas. It can be seen from the capitalisation of money that farmers borrow to undertake a new investment and adoption of technology. Moreover it can be used for smoothing consumption by providing working capital and reducing poverty as well.

The problems arise as many studies showed that not all the rural society have opportunity to get financed, either from formal or informal credit institution. In rural areas of Central Sulawesi Province the percentage of households who have access to credit up to 51 percent, which financed by formal loan only 15 percent whereas large share borrow from informal sources. In general, loans borrowed from both institutions are rarely used for finance agricultural activities. The poorest use the borrowed loans for food and consumption activities account for 60 percent meanwhile only one percent for agricultural activities. For the less poor households, borrowed loans are used for either for food and consumption or agricultural activities, 34 % and 31,% respectively. Those findings prove two important questions: 1) why do rural households have different access to credit? and 2) why is informal credit more attractive for the rural households although the formal institutions exist in every sub district (kecamatan)? Therefore accurate assessment of determinant households access to credit is important in order to understand the circumstances. By using econometric model the determinant of households access to credit both of formal and informal credit institutions will be analysed.

Data was collected in 2000 and 2001 through standardised, of formal questionnaires from 301 randomly selected households out of 12 villages in rural Central Sulawesi, particularly in the vicinity of the Lore Lindu National Park. This study is part of the Collaborative Research Centre 552 “Stability of Rain Forest Margins”.

Keywords: Rural households, Indonesia, access to credit, regression analysis

Attitudinal Compromises between Risks, Returns and Resource Use among Maize Farmers in the Dry Savannah Zone of Nigeria

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A number of programmes aimed at agricultural and rural development have been put in place by various levels of Nigerian government at different periods. However many of these programmes have recorded unprecedented low success. It has been demonstrated that the limited success of Nigeria in rural development programmes is due to the absence of a prior analysis of attitudes towards risk inherent in new technologies and the inability to ascertain the farmers' trade-off between risk and return in traditional agriculture. Also, the observed factor use of farmers reveals the underlying degree of risk preference and that this inherent inability to choose based on risk preference affected farmers' adoption of technology.

This paper therefore assesses the level of resource-use within different farm plans, determines the returns accruable to these plans to evaluate the levels of trade-off that farmers can allow in the face of estimated risks. This essentially forms a resultant compromise with groups of farmers. To achieve these, a variant of linear programming, the minimization of total absolute deviation (MOTAD) is employed to determine the optimum resource-use and the trade-off between risk and return.

Results of the analyses revealed that reduction in risk level does not have any noticeable effect on the number of enterprises that form the optimal risk minimized plans for low risk farmers. For medium risk farmers, there is increase in returns as one moves from risk minimized plans ii to v, this brings about a general improvement in return. Capital and off-farm resources are also put to full use. The interaction of risk, return and resource-use vindicate the risk attitude of the high-risk averse maize farmers, with very high proportion of family labour employed for each farm plan. Own capital and off farm resource are completely used while borrowed capital, though adequately used, decrease with decrease in use.

The authors recommend that the focus of the research be diversified to include farming systems that integrate livestock so as to investigate the influence of its interaction with crop production and to intensify market research programmes to enable farmers reap the maximum benefit of farming.

Keywords: Attitudinal compromises, dry savannah, minimization of total absolute deviation (MOTAD), risk attitudes

Microfinance for Women in Least Developed Countries — Experiences from a Case Study in Rural Tanzania

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Microfinance is a widely accepted tool to further economic development and to enhance welfare. Different lending methodologies exist, i.e. credit unions, village banking, microfinance banks, and solidarity group lending. Still, research normally limits itself to general issues that relate to all microfinance types. Less attention is given to particular features of specific models. This paper presents findings of a case study of group loans for poor women showing the significance of group organisation, the target group's perception of the microfinance service offered, and gender issues as success factors of this specific microfinance model. The target group's organisational capacity has only recently entered the regard of microfinance research. Because the members of a credit group are jointly liable for the loans received and monitor themselves they need self-management which requires organisation building. Groups which are solely created for a microfinance project often lack social cohesion and the members lack commitment towards the group. Tapping the social capital of already existing groups might improve project efficiency. Problems may arise if a microfinance project claims to be a charity organisation while simultaneously trying to offer financial services on a sustainable basis. Such projects frequently experience that the target group perceives the loans as gifts and defaulting becomes a serious problem. Separating the microfinance service from other services may be an answer for projects that follow a comprehensive approach. Some microfinance projects for women try to overcome women's discrimination as regards access to productive factors, i.e. capital. But these projects may also fail exactly because of this discrimination since financial capital is not the only missing factor. Most women lack access to land which is crucial in rural agricultural societies. African women also lack time due to their extensive and strenuous work obligations. They further lack decision making power as how to spend their time and where, and in many cases also how to spend the money they have generated on their own. Thus, women have very limited possibilities to use microfinance services. In this sense, taking a closer look to the specific circumstances may positively contribute to microfinance projects' sustainability.

Keywords: Case study, microfinance, success factors, women

Small Scale Coffee Production and Institutional Support within Cameroon's Liberalised Economy — An Explorative Study of Coffee Farmers' Strategies

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Liberalisation and structural adjustment have deeply affected agriculture in Sub-Saharan Africa. Cameroon disposes of advantageous natural conditions to produce export crops, such as coffee, cacao, rubber or palm oil. Coffee as the second most traded commodity world-wide is a typical global good on a highly competitive market.

The study explores how living and working conditions of farm families have changed as a consequence of liberalised policies. The situation of small scale coffee production is analysed using case studies and applying a holistic point of view by looking at external as well as internal factors.

Traditionally, cultivation of coffee in the Highlands is done within small and highly diversified farms bringing modest prosperity to its growers. With the fall of prices it lost importance or has disappeared altogether. Farmers have different strategies to cope with the situation. Some look for off-farm activities or tests new farm patterns. Young farmers particularly diversify and go into vegetable production. "Discouraged" farmers transform coffee areas while "hopeful" farmer keep up with intense coffee production still using fertiliser, chemicals or pig-dung. Typical reaction patterns are presented as case studies.

The arabica coffee sector has experienced the breakdown of the traditional public cooperative system. Free competition exists between licensed buyers, mill owners, and exporters. Farmers are allowed to form producer groups. In order to support them, an interactive research and extension system was installed in 1998. Extension adapted the T and V methodology of the World Bank, while research runs commodity programs. Priority was given to participatory decision making at the village level, use of indigenous knowledge, and the establishment of feed back mechanisms. However, the concept of top-down technology transfer is still very much in use. In the case of coffee, applicable knowledge is neither produced nor disseminated. Thus, farmers are left alone in their search for alternatives.

Only the collaboration between World Bank, bilateral donors and projects, research and extension, as well as government and private actors in rural areas could make coffee policies more coherent.

Keywords: Liberalisation, coffee production, research and extension systems, Cameroon

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Are Private Farm Management Centers Feasible in El Salvador?

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This paper evaluates the economic and the financial viability of implementing private farm management centers (FMC) in El Salvador. To pursue this objective, a classification process was used to create a set of representative farms. Then, enterprise and whole-farm budgeting techniques are used to calculate net benefits without FMCs. The benefits of the FMCs are projected assuming that alternative services are provided. These alternatives are developed to simulate farm improvements that are expected from the services provided by the FMCs. The financial and economic impacts of the farm improvements are calculated using multiperiod linear programming models.

To compute the benefits of the FMC as a whole, the incremental net benefit of each representative farm is extrapolated to the population that they represent. The viability of the FMC is examined using the financial and economic net present value (NPV) and internal rate of return (IRR). Lastly, to assess the inherent risk of the project, a sensitivity analysis is conducted.

The data used in this evaluation were obtained from a variety of sources. The socio-economic characteristics of the farmers come from a survey administered to farmers randomly selected from cooperatives associated with the FMCs. This survey also contains individual enterprise budgets for different crops cultivated in each farm during the 2001–2002 agricultural year. The financial, accounting and marketing information was obtained from records collected by the FMCs. Secondary sources are also used to compare, expand and improve the data available.

The main results of this analysis suggest that a combination of better farm prices (paid and received), reallocation of resources, and crop diversification that would be promoted by a farm management center can lead to increases in farm profits that would be sufficient to cover the operation of the FMC and still generate net gains in household income.

Keywords: Cost-benefit analysis, developing country, El Salvador, farm management centers, multiperiod linear programming, private agricultural extension

Potential of Futures Market for Rice in Thailand

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A Futures Market is a centralized marketplace where commodities in the form of futures contracts are bought and sold for future delivery. Futures markets are used primarily to reduce risk and not to make or take delivery. There are 68 futures markets around the world that trade agricultural products. In Thailand the ground works to establish a futures market began in 1979. However the process to set up this market was interrupted by the economic crisis in Asia in 1997–1998. The Thai Agricultural Futures Trading Act was enacted in 2000. Thai government approved a 5 years budget for establishing the futures market in Bangkok, Thailand in 2001. The process to establish futures market has been accelerated recently.

Futures markets (FM) have economic effects both directly on the prices of commodities and indirectly on production, consumption, and storage decisions responsive to prices. FM also provide an efficient mechanism for allocating price risk from those who wish to avoid price risk to those who are interested in bearing the price risk for a potential return. Because of specific risk and return positions, FM reduces transaction costs below those of cash markets. Given the investments by Thai government into the establishment and considering the theoretical economic benefits of a FM, the objective of this study is to assess the expected welfare generated by coming FM in Thailand versus expected costs, and financial profit or loss over time. The welfare analysis is used to determine consumer surplus, producer surplus and total welfare of FM in Thailand. The financial cost/benefit analysis is applied to forecast profit and loss of coming Thai futures market over time. The result of this study is a quantification of the social welfare generated by the FM in Thailand, justifying its financial costs of establishing it in such a way that it will be financially self-sustaining in the long run.

Keywords: Futures market, rice, welfare

Impact of Credit as Perceived by Resource-Poor Ethiopian Households

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Severe land degradation, low land productivity, proneness to drought, and consequently chronic food insecurity characterise the wereda of Atsbi-wemberta in Tigray, northern Ethiopia. Possibilities to enhance agricultural activities are limited, therefore the poor have to diversify their range of income-generating activities. Financial capital is one part of a sustainable livelihood, as all activities require basic capital to get started. This paper reports on the results of a survey in 97 households and 5 group discussions, carried out in 2002. Survey results were analysed using SPSS. The impact of formal and informal credit on households' livelihoods as perceived by them were investigated.

Generally, the interviewed households perceived having access to credit as positive. Especially valued was the importance of credit for their self-esteem by enabling them to take up some activity and consequently being less dependent on food aid. But several households had examples of clients of the Debit Savings and Credit Institution (DESCI), the local micro-finance institution, being worse off than before, lacking the skills to successfully invest the money. Additionally, many clients had used credit for food consumption and experienced problems repaying, having to sell their scarce livestock. Mostly, households agreed that informal credit consisted of too small sums and regarded formal credit to have a greater impact. But, there were also indicators that the formal and informal credit market complement each other, being used for different purposes, and informal credit being less bureaucratic. Informal credit from friends or relatives was widely used, often in times of temporary problems, e.g. to smooth food consumption, or to pay for additional expenses, e.g. social events. The assumption that female headed households are more interested in diversifying their range of income sources and might therefore be more in need of credit, did find supporting evidence in this study. They were more often engaging in new activities with their credit than male headed households. To conclude, having access to credit certainly can improve the livelihoods of some poor households, but has to be part of a wholesome approach.

Keywords: Female headed households, micro-finance, sustainable livelihoods

Necessity of Change of Research about Iranian Rural Women and Improving the Executive Development Policies

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Human resources are the first priority in development programmes. As about half of the human resources are women, they should be essential goal of development policy. Without paying attention to the role of rural women in the process of developing rural areas, we cannot get to a national development.

The role of rural women in the agricultural economy of Iran, specially in the independent rural effectiveness system, is in a form which dominates more than half of production process in agriculture. Rural women are the hidden human forces in the process of rural production and are not even seen by the other rural people and even their husbands.

In the field of planning policy from centers of decision making about women's various issues, we can refer to two different kinds of thought during past 10 years. First group have based their main aim on increasing the amount of women's cooperation in productive and economic activities out of homes. The second group have based their objective on women's role at home and inside their family.

Research about women's issues in Iran has not a long history. For accelerating the development of rural societies and reforming the process of development, and promoting the possibility of women's access to the resources, the research and educational system in the field of rural women's affairs should be changed. For example we can research in these fields:

- Research about the existing reality of rural women's life and their activities inside home. In most of the studies women's inside family and agricultural activities are not considered.
- Research about women's needs and their point of view toward their life.

The outcome of these studies are the considerations which make the officials of agricultural development section to pay more attention to women in the process of giving services and allocating resources to rural society. Besides a major change in research system, the change in decision making system and planning policies is also enjoying certain importance.

Keywords: Rural women, Iran

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The Role of the State and NGOs in Development

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The number of NGOs during the last two decades has grown enormously, both at the national and international level, as has their role and influence. The rising relevance, influence and public attention that the NGOs scene enjoys — not seldom encouraged by spectacular actions — raises a number of issues and questions that the paper attempts to address. These include, apart from the difficulties to define an NGO, their role and relationship vis-à-vis the State, their source of legitimacy, their efficiency and accountability. In relation to government institutions are NGOs better suited to work at grassroots level and in locally based development programs? Should governments instead address the macro policy and institutional framework issues? Who conveys legitimacy to NGOs and to whom are they accountable?

But NGO's influence today reaches far above the boundaries of individual states; they play an active and increasing role in shaping globalisation processes and global governance. Is this development reflecting a move away from the nation state to global decision-making processes as national governments are no longer sufficient to make decisions on transboundary issues, such as development, environment and gender? Can internationally acting NGOs take on mediating and coordinating functions?

The important role that NGOs play in national and international decision making suggests a need to create formal ways for their involvement in institutions of global governance, as for example in the WTO. This could benefit global governance institutions by mobilizing public support for their actions and raise NGOs legitimacy and responsibility.

Keywords: Global governance, legitimacy, grassroots level

The Role of State in the Management of Farmer-Herder Conflicts in South West Burkina Faso

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In the South West of Burkina Faso conflicts between farmers and herders are frequent and sometimes violent. For efficient conflict management, the state has to contribute structurally as a legislator and personally as an alternative mediator, if conflicts between farmers and herders escalate. This paper explores the current role of the state, its potential and weakness. From October 2001 to June 2003 a study on conflict management was undertaken in the Poni and Nounbiel Provinces. 124 households and the local authorities in six villages participated in semi-structured interviews and focus group interviews. Also representatives of the regional (administration, projects) and national (government, NGOs, etc.) meso- and macro level were interviewed to identify their involvement in and perception of conflict management.

Conflict management between farmers and herders at the local level (between the concerned or by local mediators) was preferred by all parties. However, departmental or regional state authorities (Prefect, Technical Service, Justice) were involved if management at local level failed. But this immediate role of the state in the arena of conflict management was viewed skeptically. Due to obscurities in compensation measures and the perturbation of social ties, if the conflict goes beyond village borders, actors disgraced the state. The legislative role of the state to define framework conditions was also seen critically. Land tenure right and decentralisation were mentioned frequently as conditions with a potential impact in conflict management at local level. But, as many informants remarked, contradictions between different elements in and between the actual bills for decentralisation and land tenure reform still exist and a marginalisation of rural areas, particularly of pastoralists, is feared.

It seems, that the state is too weak to fulfil his immediate responsibility as an alternative mediator. For formal (financial and technical) and informal (distrust) reasons the state has low credibility. Thus, the challenge is to support and strengthen local institutions for conflict management by the development of efficient framework conditions.

Keywords: Burkina Faso, conflict management, pastoralists, state

Assessment of Performance of Existing Rural Cooperative Medical Scheme and Willingness to Pay for Improved Scheme in Rural China

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Fair financing is one of three overall goals of health system. The stress of fairness in health care financing is not only an ethical consideration, but because of the negative externalities of poor health. Communicable disease of an individual may be quickly spread among a host of people or even globally without instant containing system. Health care delivery system alone is unable to achieve the goal of fairness of financing; only with the help of various mechanisms of health care financing can fairness be accomplished. In China, the widening urban-rural inequality in health may, besides the income discrepancy, derive from the unfair health care financing. The urban social insurance has been steadily established on the basis of employment. However, the majority of the rural have to pay for health services out of pocket at the moment of services utilization. The rural cooperative medical scheme (RCMS) has been an important institutional innovation of health care financing in rural areas by which a small portion of rural population has been insured.

Despite many efforts made to revive the RCMS, effectiveness remains poor. There is, therefore, an imperative need to reassess the performance of RCMS in achieving goals of fairness and better health. Three approaches are adopted to assess the performance comprehensively on the basis of the six-province dataset: after-before analysis over time, with-without analysis across regions and a close case study of some RCMSs in Sichuan province. The results are a little disappointing: Only RCMSs before the overall economic reform played a significant role in improving fairness and overall health.

To make RCMS more desirable, an improved RCMS was hypothesized and willingness to join (WTJ) and to pay (WTP) was investigated among 300 sampling rural households in 10 villages of 5 counties of Sichuan province at the beginning of 2002. Findings show that WTJ (69.3%) hypothesized RCMS is not very high in consideration of the high enrolment rate (over 90%) of RCMS in 1960s and 1970s. However, WTP for hypothesized RCMS with half co-payment (similar to the present reimbursement ratio) is much larger than the present RCMS if upper governments could ensure the strict management of insurance fund. The performance of RCMS does affect the WTJ and WTP. Moreover, head attributes (age, mother's, education and ethnic group), household attributes (distance from center, whether with migrant worker) as well as income are closely related to WTJ and WTP. To sum up, the traditional RCMS could be substantially improved by extending its benefits package and strengthening insurance fund management.

Keywords: Rural cooperative medical scheme (RCMS), resource mobilization, health risk protection, health status, contingent valuation (CV), willingness to pay (WTP)

The Effect of Recent Institutional Innovations on Rural Communities in Bolivia's Amazon Region

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Between 1996 and 2000, the legal foundations of rural communities in northern Bolivia have changed substantially. In the departments of the Bolivian Amazon, where more than 90 % of land area is natural forest, this has an effect primarily on the use of forest resources by indigenous and peasant communities: Formally acknowledged communities (according to the 'Ley de Participación Popular') are allowed in the areas assigned to them as community land (according to the Laws of Agrarian Land Reform) to commercially use timber and non-timber forest products on the basis of forest management plans approved and supervised by the forest administration (according to the 'Ley Forestal').

The new legal framework has raised high expectations in the roughly 300 rural communities existing in this region, especially concerning the commercial use of tropical timber. Actually, land allocation towards rural communities is making progress, so that increasingly a basis for communal forest management is emerging. However, field research shows that the establishment of sustainable forest management through the communities is hampered by serious internal and external difficulties:

- The weakly equipped local administrations are not prepared to appropriately cope with the new requirements.
- Limited access to information and external support makes it difficult for most of the communities to prepare and undertake the necessary steps to acquire the new property rights.
- An effective functioning of the communities is also hampered by the fact that their self-administration is of recent development and that conflicts arise from opposing interests of community members.
- The communities lack experience with "sustainable forestry", as well as with adapted models for their internal organization of community forestry. Empirical evidence suggests that more and more communities will make themselves dependent from regional logging entrepreneurs, which may put at stake the official goal of introducing sustainable forestry on a community basis in this region.

Our research is presently oriented towards identifying approaches to overcome institutional problems that present the successful implementation of communal land use.

Keywords: Bolivian Amazon, community forestry, land use reform

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Assessing Chances of Success for State and NGOs in Rural-Environmental Policy Networks through Quantitative Network Analysis — A Typology of Success Factors

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Development requires success and success requires political power. The aim of this analysis is to present a typology of factors that improve the chance of success (power development) for state- or NGO-actors during their policy-making in rural networks. The theoretical basis is the New Institutionalism and power theory. Policy networks are systems of interactions (cooperation or conflicts) expressed through exchange relations like (mis) trust, commitment, and information etc., concerning specific policy issues. A general factors' typology is the result of quantitative network and statistical analysis based on data from 12 policy networks in 8 countries. This will be illustrated using selected country cases and specific features of rural policies. Considering this typology, one can advise an actor to join a network or not. These factors are *actors'* and *network characteristics* combined. This typology includes 5 types: 1) the "lawful" type: An actor with a multidisciplinary team that is lawful but not state-controlled has its optimal chance in "non-crowded" and mono-sectoral networks with intensive state contacts and low importance of state. 2) The "trustworthy" type: A trustworthy actor with multidisciplinary team and various financing resources has its optimal chance in a "non-crowded" network with intensive state contacts and low importance of state. 3) The "minor brother" type: An actor with powerful partners and various financing resources has its optimal chance in a mono-sectoral network with "equal chances" where many possible contacts are still unexplored. 4) The "omniscient" type: An actor who already possesses power can impose its general and scientific information as "important" and control the distribution of general information in a network with no needs of resources. 5) The "re-constructor" type: an actor who already possesses power can impose its general and scientific information as "important" in a network with no scientific links, if this actor receives occasional general information from others and redistributes it.

Keywords: New institutionalism, power factors, rural policy networks

Property Rights and Land Tenure Security in El Salvador

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The proposition that legally secure and complete individual property rights over land boost investment has been examined in historical, theoretical and empirical literature. This proposition suggests that property rights are a key to unlocking economic growth in low-income economies. If legally insecure property rights weigh most heavily on low-income households, then public policy designed to enhance the security of individual property rights over land would seem to be a “win-win” policy scenario that promotes both economic growth and income equality. Therefore land titling programmes should enhance poor-households’ welfare by facilitating the use of land as collateral for credit access, and also for reducing the risk of losing land-fixed investment. The outcome depends critically on the way liberalized land and product markets functions in the existing world of imperfect rural markets.

This study analyses the impact of changing property rights on land in El Salvador, a country where major land reforms and policy reversals during the last three decades have cause widespread tenure insecurity. I develop theoretical and empirical arguments based on security of tenure as independent exogenous variable. Regression analysis is used to explore the channels through which property rights influence socio-economic outcomes.

It is found that formal land documents reduce tenure insecurity, enhance the value of land, encourage uptake of perennial crops and thereby boost crop yields. Formal title deeds are superior to land reform documents, in that the value of land increases. Land title has no effect on credit, contrary to common assumptions and there is statistically proved evidence that it results from two main issues: from the extra risk attached to former guerrilleros who supported a debt write-off in the years 1999 to 2000 and second from the fall in land prices which makes small parcels of land not usable as collateral. The results also show a strong and significant positive impact of tenure security on land-fixed investment, nonetheless the positive effect of tenure security on investment are dampened by an unfavourable liquidity constraint effect for households. Support for continuing the process of land titling appears justified on both equity and efficiency grounds.

Keywords: Credit, land reform, property rights

Community Agreements on Conservation as an Approach for Sustainable Rural Development — Case Study of Lore Lindu National Park Central Sulawesi, Indonesia

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Negotiated agreements between local communities and state agencies concerning the management of natural resources as an approach for sustainable rural development have gained increasing importance in recent years. This approach is an effort to find a balance between the goals of nature conservation and the objectives of the local communities to secure self-determined sustainable livelihoods. Protected areas in developing countries are one of the fields where negotiation approaches are particularly promising, because conflicts of interests are frequently observed and conventional strategies of state-management have often failed. Taking the case of community agreements on conservation in the Lore Lindu National Park, Indonesia as an example, the paper analyzes such agreements from the “*perspectives of economic analysis*”. From this point of view, the problems of nature conservation arise due to negative external effects that are associated with the use of natural resources. Environmental economics literature draws that negotiated agreement is considered as a policy instrument that represents the bargaining solution to solve externality problems. The empirical analysis shows that the agreements differ considerably, depending on the value orientation and objectives of the NGOs promoting the agreements. Two NGOs were taken into consideration: an international conservation NGO and a local NGO with a strong emphasis on advocacy for indigenous rights. The study shows that this model offers useful insights in the logic behind the different agreements promoted by these organizations. The study concludes that community agreements on conservation represent a compromising approach to improve the management of protected areas in order to sustain rural development. Nevertheless, the internal differentiation within the communities represents a challenge to this approach.

Keywords: Deliberative democracy, sustainable rural development, negotiation, Indonesia

Integrating Non-Governmental Self-Financed Residential Social Care Services into the Context of Local Rural Development

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Governmental organizations in developing countries can rarely provide sufficient support for socially marginalized groups in society. Intermediate –yet unsustainable– solutions to meet the needs are apprehended by non-governmental organizations that rely on external donors. A potential mid- to long-term alternative may be the implementation of economically autonomous social institutions that rely on the contributions from affiliated small enterprises and are integrated into its socio-economic context.

The objective of the study was the analysis of the situation of a to be autonomous orphanage in the rural areas of Bolivia and the identification of strategies for a successful integration into the development of the surrounding village. Data about the orphanage and local household systems were obtained from local residents by open interviews and a standardized questionnaire. Econometric methods were applied to compare income generating strategies of local socio-economic units. An index that takes different dimensions of integration into account was used to measure integration of local household systems with local groups and the orphanage. A model was constructed to test scenarios of integration.

Resource endowment of local household systems determines their type of income generating strategy. The orphanage pursues similar income generating activities (farming) like local household systems thus being in competition with them. Operating in the same local context, the orphanage pursues also distinguished income generating strategies (reliance on transfer-payments) that are not accessible to local socio-economic units. Thus the orphanage activities have been irrelevant or hampered local income generating strategies rather than supported them in a sustainable way. This is reflected in the integration of local household systems with the orphanage which is lower than integration with other local groups. Yet potentials and areas have been identified that might serve as a basis for mutual benefits like 1) community-oriented projects of the orphanage, 2) participation and fostering networking, 3) facilitating farmer groups and/or 4) renting-out orphanage land and stopping farming-activities of the orphanage.

Keywords: Bolivia, non-governmental organizations, rural village systems, social services

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Role of Agricultural Cooperatives in Agricultural Development of Menoufiya Governorate, Egypt

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Agricultural cooperatives are considered to be important social and economic units aimed at developing agriculture. In Egypt, these organizations are expected to play a very important role in dissolving the rural society problems and improve the future development in agricultural production and to stabilize balance between imports and exports. The main objectives of this study are determination of variables affecting the following items: 1) Agricultural cooperatives' ability to mobilize resources for achieving its activities. 2) Agricultural cooperatives' ability to employ the available resources. 3) Contribution of the agricultural cooperatives in agricultural development. 4) Organizational effectiveness of the agricultural cooperatives in agricultural development. To achieve the study objectives, a questionnaire was designed and data were collected through personal interviews with 66 directors of agricultural cooperatives in Menoufiya Governorate, Egypt. The study includes 21 independent variables which affect the previous 4 dependent variables. The Step-wise multiple regression analysis revealed that: only 6 independent variables namely, number of population in the villages, the ribbons areas (both of them are served by the agricultural cooperatives), the cooperation level between agricultural cooperatives and governmental organizations in the village, the extent of agricultural cooperatives building suitability for achieving their activities, the total number of NGO membership of agricultural cooperative directors and governmental organizations were found to have significant and positive effects on the above mentioned 4 dependent variables.

The results indicate that the importance of the small agricultural cooperatives united to form central economic units to increase their incomes and effectiveness. During planning of agriculture development, the government should activate the coordination and cooperation among the roles of both agricultural cooperatives and other organizations in the villages to enhance their importance roles, abilities and the organizational effectiveness in the agricultural and rural development.

Keywords: Agricultural cooperatives, organizational effectiveness, agricultural development, central economic units, Menoufiya governorate, Egypt

The Dynamics of Land Tenure in the Poni and Nounbiel Provinces, Burkina Faso

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Burkina Faso is a typical example of overlapping modern and traditional land tenure systems. Especially in rural areas, the customary systems persist, whereas the modern legislation is not yet implemented. Furthermore, the South-West of the country is strongly concerned about land conflicts due to the immigration of Fulani pastoralists. In a six months study, six villages were investigated in the Poni and Nounbiel provinces by semi-structured interviews with farmers, pastoralists and officials of regional institutions. During two field phases, basic data were collected in 374 households, of which a stratified sample was drawn for collecting information about land tenure, interethnic relations and conflict management. Several changes in the traditional land tenure system could be observed: The earth priest previously solely responsible in matters of land access and conflict management is nowadays assisted by an administrative delegate. Their responsibilities are complementary: The earth priest remains the spiritual village head and is responsible for land tenure and land allocation, whereas the administrative representative, whose role can be compared to that of a mayor, is responsible for conflict management. Results show two new developments in land access: Firstly, the hierarchical village structure is changing towards a more individualized system: Land remains common property, but is allocated to concession chiefs and not to clan chiefs any more, and the number of households per concession decreases. Secondly, the importance of land loans which play a secondary role in the customary system increases in consequence of the foreigners' immigration. Almost 30 % of the investigated Fulani have taken their land on lease. Exceptional conditions were found in the village Kour where the Fulani population is above average with 34 %. Only here the Fulani consider themselves as owners of the land they cultivate, whereas in the other villages, they accept the autochthonous settlers as owners and sometimes even complained about legal uncertainty. Despite a higher conflict frequency due to the higher density of cattle, the interethnic relations in Kour are reported as good. This shows that security of land access is an important precondition for a fruitful coexistence of farmers and herders.

Keywords: Burkina Faso, land conflicts, land tenure, property rights, West Africa

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Challenges and Policy Options for Sustainable Rural Development — Policy Measures

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To sustain their livelihoods in the short run, rural households are often compelled to deplete their soil nutrients, overuse their water resources and degrade their forests. The result is a downward spiral of over-exploitation of natural resources and increasing poverty. Global environmental changes as well as human-induced local changes, e.g. population growth and migration, have accelerated this downward spiral and contributed to an increasing vulnerability of environmental and human systems.

Two types of complexities make it difficult to identify appropriate policy options and implement corrective policies: (1) complex environmental and economic interactions affecting the availability and quality of natural resources, and concomitantly, household decisions on resource use; (2) complex social interactions between different stakeholders who are socio-economically and culturally diverse and who often have competing interests and power relations. A major research approach to deal with environmental and economic complexities is integrated simulation modelling, which combines hydrology, soil, climate and crop models with economic models to explore how policy interventions may impact on natural resource use, and subsequently lead to changes in production, income and household and community welfare. A particularly promising new development is multi-agent modelling, which captures the interactions between resource users (the “agents”) and resources used (the “environment”). Alternatively, approaches to deal with the social and institutional complexities of resource management and rural development have focused on researching the governance structures, the patterns of participation of different stakeholders, and how integrated resources management is applied in practice. Major methodologies used include action-oriented research, and the application of analytical concepts such as property rights analysis, collective action theory, game theory, and legal pluralism.

Integrating the lessons learned from these separate approaches remains a critical challenge. Though simulation models provide scientific information to identify policy options for sustainable rural development, the implementation of corrective policies involves value judgments that have to be politically negotiated within appropriate governance structures. Of critical importance to the success of sustainable policy measures is bridging the gap between scientific information and stakeholders’ knowledge and perceptions.

Keywords: Integrated simulation, modelling, policy development, stakeholder interaction

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The Effects of Indonesia's Decentralisation Policy on Forest Conservation — Evidence from Four Villages in Central Sulawesi

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One outcome of the ongoing democratization process in Indonesia (reformasi) was the policy of regional autonomy issued in May 1999 and implemented since January 2001. It resulted in devolution of power to the district and sub-district level as well as in deconcentration of authority in the forestry sector.

This paper investigates the effects of this policy on local communities and their forest utilization in two sub-districts in the province of Central Sulawesi. These villages border the Lore Lindu National Park and are situated in a region characterized by rapid deforestation and heavy encroachment into the protected area. Research was carried out during the initial phase of the decentralisation process in the years 2001 and 2002. As a result of the decentralisation the structure and power divisions of the village institutions was altered. This included the transfer of legislative authority to the village level. The local communities' responses to these institutional changes, in terms of implementation and in terms of how they used their newly acquired authority, varied considerably.

Also, there were indirect effects: The devolution attempts in the forestry sector led to village agreements in a number of villages in the research region. While these agreements may have effected a more sustainable forest management in these localities, it may also result in a decreasing legitimacy of the National Park's authority in villages, where this policy has not been implemented. This is due to the fact that these agreements are not seen as an institutional innovation, which once may be applied on one's own village. They are rather perceived as unfair preference of villages that enjoy strong support of NGOs.

Besides these dynamics, we could also observe a change of attitude toward government officials — in this case the park rangers — as a result of reformasi. In the final section, we delineate — by comparing the findings from this study with case studies from other regions of Indonesia — if and how political decentralization can contribute to the objective of a more sustainable forest use. The facilitating and the limiting factors of a successful linkage are identified.

Keywords: Decentralization, deforestation, Indonesia, local communities, National park

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Regional Autonomy and its Implication in Rural Indonesia

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Indonesia's political map has drastically changed since the reform movement of 1998. The most important political reform related to rural development is regional autonomy, which reflects a broader process of political and economic reform. The substance of regional autonomy is that the central government decentralises fiscal, political and administrative responsibilities to the local government. While there is a growing consensus that indubitable decentralisation policy is important for reaching equity goals, it is still difficult to arrive at definitive recommendations concerning which form and degree of decentralisation will be optimal. The best design will vary depending on circumstances, institutions, and the complexity of situation.

Regional autonomy has given voice to local demands and responded to the need to bring economic and political systems closer to local communities. However, there is an alarming tendency after two years of regional autonomy. A short-term orientation policy, such as maximizing the extraction of natural resources, is a mainstream policy in most of Indonesia's regencies following the regional autonomy, due to the target of achieving higher regional incomes, political bargaining, and getting personal benefits. It is difficult to shift the local policies in a more sustainable way because of a mutual benefit of bureaucrats, political actors and people in majority. This situation has led to a massive environmental degradation. In Jambi province, for instance, the annual deforestation rate increased more than five times from 1.29 % (1990–1999) into 7.28 % (1999–2002). Empirical data also indicated that besides a higher per capita income, the disparity of income in some rural areas is also higher. Result from a recent socio-economic survey in the three villages of Jambi province shows that the average Gini coefficient was 0.47. It is higher than the income disparity at national level that was only 0.32. This is not only a warning for local governments to make better policies, but they also need a serious commitment to realize them.

This paper is intended to analyze the implications of regional autonomy in rural areas both from a normative and a positive perspective.

Keywords: Decentralisation policy, regional autonomy, rural development, Indonesia

Farming Systems and Policy Options for Food Security in Southwestern Nigeria

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Farming systems analysis is a holistic approach to the understanding of total livelihood and food security of farm families. A sound knowledge of the prevailing farming systems in an agro-ecological zone is pertinent to the generation of agricultural and food security policies for farming families. This ensures that innovations to be developed are suitable to meet the economic needs of the various homogenous groups and have a high probability of being accepted by the farm families.

An earlier study identified seven factors as some of the proxy variables representing the pillars of food security in rural Nigeria. The study was carried out among 150 farm families in rural areas of Osun state. This present study classified the same set of farm families into two farming systems from the same set of data (perennial and permanent rain fed farming systems). The classification is necessary to determine if there are differences in the factors discriminating between the food secure and insecure between each of the farming systems. Perennial specializes in the cultivation of crops designated as both food and cash crops, while permanent rain fed cultivates only food crops.

Data from the same set of families were utilized along with the backward stepwise discriminant analysis. 19 proxy variables representing the three pillars of food security were captured. Results show that there are both similarities and differences in factors determining food security of families between the homogenous groups of farming systems, which is a reflection of the peculiar features of each system. For the perennial farming systems, 5 variables: household size, farm size, percentage off farm income, number of days loss to illness and per capita income per day are significant. For the permanent rain fed farming systems, 4 variables: accessibility to the market, number of days loss to illness, per capita income per day and amount spent on illness are significant (ranked in the decreasing order of their relative contribution to household food security for each system).

Keywords: Discriminant analysis, food security, farming systems, perennial, permanent rain fed

Indonesia after Decentralisation — The Changing Roles of Public and Private Actors in Environmental Regional Programmes

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The decentralization program in Indonesia implemented in 1999 has given far-reaching authorities to the regional government in many fields. With respect to natural resources, central government devolves the authority to manage available natural resources and maintain environmental conservation on land and in water to regional government. This paper discusses several implications of decentralization program especially in forestry sector in the province of East and Central Kalimantan. Shortly after the issuance of the law of decentralization, the central government implemented the decentralization process in natural resources management by releasing legislation (PP no. 6/1999) that devolved elements of authority to manage forests from the central government to the regional government. Now, the regional government are allowed to grant concession up to 10,000 ha. In sum, this regulation provides opportunity for private sector companies as well as local communities and cooperatives to take part in forest resource exploitation. As a result, the number of forest concession applications increased significantly and covered hundreds of thousands of hectares of forestland in East Kalimantan alone. This situation increased logging activities and the production of log and timber. The logging industry generates employment and income for local community. Through permit issuance, fee and tax the regional government can generate their income (gross domestic product). However, local people can only participate in logging activities as workers due to the limitation of capital. People who primarily benefit from this chance are those who own capital. As a result, the rate of income disparity among people living close to forest is relatively high. Besides, the high level of log and timber production results the high level of deforestation. This deforestation will obviously lead to the loss of natural resources and biodiversity and increases the risks of natural catastrophes such as flooding, landslide, drought and insect infestation. Changing roles of public and private actors have accelerated the exploitation of natural resources in Indonesia. Although this process has some undeniable positive consequences in the economic and social sectors, negative consequences on the environment are also obvious.

Keywords: Decentralization, deforestation, forest resources, private and public actors

Economic Cost of Occupational Human Health of Pesticides among Agricultural Households in Africa

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Using field data combined with bio-medical and laboratory analysis, this study identifies the specific acute human health problems that are associated with pesticide use among agricultural households in the intensive cotton-rice production system of Côte d'Ivoire, West Africa. The health problems identified by farmers were quantified in economic terms using a methodological framework developed in this study. The results show that the most important acute human health symptoms linked with the use of pesticides are headache, catarrh, cough, skin rash and sneezing (in order of importance). The costs of the health symptoms on farm households are multi-dimensional including damage costs, mitigation cost and avoidance costs. Pesticide applicators face four times greater risk to fall sick than an average member of the same household who lives under the same conditions. Households recognize pesticides as one important cause of ill health, but over the years some of the symptoms have been accepted as 'integrated' part of spraying pesticides. In the making of decisions on field practices, households generally take into consideration only the direct out-of-the-pocket expenses but ignore indirect costs associated with pesticide use. Only in 2 % of the cases linked with pesticides do household members visit official health centers to seek formal medical assistance. Policies to protect the health of the rural households through greater awareness of on health issues and documentation of pesticide-related health symptom cases for planning purposes are recommended.

Keywords: Cotton, Côte d'Ivoire, health cost, pesticide, pesticide externality

Indicators for the Measurement of Institutional Performance Concerning Water Management — The Case of Uzbekistan and Ghana

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The constant evaluation of institutional arrangements in any sphere of human endeavour is critical for harnessing possibilities of institutional innovations. This is particularly important in natural resource management, which holds enormous potential for sustainable rural development. This paper aims at elaborating a set of indicators that could measure institutional performance in water management. The indicators are furthermore applied on the irrigation sectors of Ghana and Uzbekistan. For this purpose, a set of indicators capturing formal as well as informal institutional performance is developed. The changes in the organizational structure of the irrigation sector in both Ghana and Uzbekistan are highlighted and indicators for institutional performance are evaluated. The choice of the two countries is motivated by apparent similarities and differences in the irrigation sectors respectively. The similarities include the fact that the institutions of water management are in transition towards private property rights regimes. Moreover, both countries are confronted with the problem of water scarcity and the negative environmental consequences of extensive water use, requiring cooperation at the international level as well as specific institutional arrangements on national, regional and local levels. The major difference is that the irrigation sector in Ghana is dominated by informal institutional arrangements while in Uzbekistan the formal institutions are overwhelming. Given the above similarities and differences, the comparison between these countries gives an indication of the performance of institutions in the transition process starting from two different ends. It also shows the functionality of formal and informal institutions in country specific contexts. The results suggest how institutional innovations could evolve in order to achieve the best possible results with respect to natural resource management.

Keywords: Ghana, indicators, institutional performance, Uzbekistan, water management

Governance in Coral Reef Ecosystems — A Case of Gili Indah, Lombok, Indonesia

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Indonesia is considered as one of the tropical coral reef centers in the world. According to a reliable study, Indonesia owns 60,000 – 75,000 km² of coral reef ecosystems. These ecosystems yield valuable products and services, which are useful for humankind. They serve as a bank of biodiversity, a habitat for many kinds of fish, sources for potential chemical and bioactive products, attractive tourist destinations, a coastal barrier, etc.

Unfortunately, those valuable ecosystems are at risk. The 1997 COREMAP project reported that only about 6 % of the ecosystems are in excellent status, 22 % good, 32 % fairly and 40 % very poor. Experts assume that Indonesian coral reefs will disappear within ten year from now if no protective measures are taken immediately.

There are many reasons why the coral reefs are approaching the point of extinction. Destructive fishing, limestone mining, live coral trading, coastal development etc. are regarded as the main causes for this development. Certainly, all these casualties may be relevant. However, in an institutionalist perspective, those assumed destructive factors are only results from inadequate institutional environments and arrangements. The main determinant is the absence of an effective governance structure or management regime which has to be based on well-designed rules, rights and duties. As long as these institutional prerequisites are missing, there will be no solution to the Indonesian coral reef problems. Therefore, changes in effective property rights and establishing new institutional rules and arrangements will be necessary.

This paper aims at analyzing the present governance structure of the coral reef ecosystems. It is mainly based on a case study in Gili Indah, Lombok, Indonesia. Furthermore, it will include a description of the legislative background, the national coral reef administrative framework, the governance at the local or district level and the village level. Three aspects of institutions at the village level will be analyzed, i.e., property right systems, rules for conflict resolution and rules for halting destructive fishing practices. The conclusions drawn may serve as an instrumental information for policy makers enabling them to find policies that can protect coral reefs from being threatened by extinction.

Keywords: Governance structure, institutional arrangement, management regime, property rights

Forest Plantation Management between Centralized and Participatory Planning — A Case Study of East Pegu Yoma Project, Myanmar

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Myanmar is one of the top ten teak planting countries. Although the plantations cannot replace all functions of natural forests, they are necessary for combating deforestation and providing increased demand of basic needs and individual wood, especially in tropical developing countries. The overall objective of this study is to contribute better strategies for plantation management in Myanmar. The study was carried out in a large-scale teak (*Tectona grandis*) plantation project on degraded natural forest area in Myanmar. Personal interviews were done with three major interest groups of EPP: the planner, the field level staff and the effected local people. A small-scale one-shot inventory was also conducted to examine the impacts of forest dwellers on nearby plantations. Research findings indicate that the planning process of EPP was carried out by a group of professionals without discussion with other interest groups. Young foresters who were assigned by the Forest department implemented the project. Local people were involved in the project only as temporary labour. Project administration was a top-down bureaucratic system and there were no transparent relations and interaction between these actors. As a consequence, a considerable amount of negative human impacts were observed in EPP plantations and the project could not achieve its expectations. Although there are some limitations and constraints for the participatory approach in Myanmar, it is important to start from a point that is suitable for current political and social economic conditions. Perspectives of all actors have to be investigated and social aspects must be included in future plantation management. Local communities must have the opportunity to participate in planning, management and benefit sharing activities of plantations.

Keywords: Forest plantation, Myanmar, participatory planning

Measuring the Policy Effects on Cotton Production in Uzbekistan

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Cotton is the major crop in Uzbekistan and an important source of employment, income and foreign exchange earnings. During the Soviet era, Uzbekistan cultivated cotton on about half of its 4.5 million arable land. Since independence the government has embarked on a program of diversification, aimed at self-sufficiency in wheat production by encouraging the gradual shift from cotton to wheat. It tried to realise a macroeconomic program of reforms, which includes privatising input and output markets, increasing production incentives, eliminating the state order for cotton, and streamlining the export system. Despite the announced program, the state continues to play a major role in the production and marketing of cotton (sets production quotas and prices, supplies inputs, purchases the crop). Those attempts of restructuring the agriculture have not brought any positive social or economic results.

This paper argues that restructuring cotton production by decreasing the areas under traditional cotton in favour of cotton under plastic, will result in welfare gains.

We test the hypothesis, according to which the production of cotton under plastic is more efficient than the production of traditional cotton. The comparative advantage of the two above mentioned varieties competing for the scarce domestic resources is calculated applying the methodology of Domestic Resource Cost (DRC) analysis, based on the data gathered in three main agricultural regions of Uzbekistan. As far as the markets for agricultural inputs and outputs in Uzbekistan are not free, the Policy Analysis Matrix (PAM) methodology is implemented to reveal and measure the effects of divergences (policy interventions and market failures), as the difference between observed parameters and the parameters that would exist if the distortions were removed. To prove the robustness of the results, sensitivity analysis (testing different policy options) is carried out.

Relying on the results of PAM, as well as on the indicators of policy distortions and economic efficiency (e.g., DRC ratios ranging between 0.54 and 0.88), policy recommendations are proposed on possible development perspectives in production structure of cotton.

Keywords: Cotton, domestic resource cost, policy analysis matrix, Uzbekistan

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Linkages Between Poverty Alleviation and Environmental Degradation — Evidence and Policy Implications from a Northern Mountainous Province, Vietnam

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Poverty and environmental degradation are acute problems in the upland regions of Vietnam. The link between poverty and environment in these areas is conventionally assumed as a “vicious circle” or “downward spiral”. In Vietnam, despite the growing literature on environmental deterioration, the poverty – environment linkages are still poorly understood. The availability of research on this topic has remained limited and does not provide Vietnamese policy-makers with appropriate guidance to achieve sustainable development in the country’s mountainous territories.

This paper aimed at providing a better understanding of the relationships between poverty and environment in 75 communes of Son La — a mountainous province located in Northwestern Vietnam, focusing on the economic transformation period (from 1989 to 2000). This could enable the decision-makers at various levels in formulating and implementing rational policy interventions as well as to avoid potential conflicts among development objectives in the upland regions.

Poverty is proxied by income and number of assets controlled by the poor, and is collected by using a structured questionnaire. The environment is instrumented by forest, soil quality and water availability variables. The aerial photographs and satellite images taken in 1989, 1994 and 2000 are interpreted to detect changes of forest resources. All data are geo-referenced and spatially analysed by using Geographical Information System (GIS) and statistical software.

The research results show that poverty alleviation and environmental deterioration are strongly linked together in the research region. However, strength of these linkages was dependent upon agro-ecological and social characteristics of the communes and periods of economic growth. The findings of the study suggest that there are some trade-offs and synergies between poverty reduction and environmental protection.

Keywords: Deforestation, environmental degradation, policy measure, poverty alleviation

The Quality of the Brazilian Agrarian Reform Settlement Projects

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An extensive field survey was conducted during the second semester of 2002, interviewing 14,414 persons in 4,430 agrarian reform settlement projects, established during 1985 and 2001 in the entire Brazilian territory. These settlements cover an area of 241,980 km² where 458,483 people are living, and nearly represent the totality of the reformed area of this period. The objective of this survey was to establish indexes representing the efficiency of land reorganization (IF), standard of living (QV), relations and social organization (IS), governments' operational action (AO), environment quality (QA), and the income of the settlement projects. The settlement projects were also compared to several external databases (soil, climate, accessibility, agricultural income and cash flow, market potential) to position them in relation to the amount of available resources on a regional and national scale. All these combined reflect the quality of the Brazilian agrarian reform process. Part of these information was organized in a book "The quality of the settlements of the Brazilian agrarian reform" available in Portuguese (printed and electronic version) and English (electronic version). As main conclusions, in a simplified way, agrarian reform can consider only the reversion of the established land tenure condition (unproductive latifundia) in family agriculture based small farms (minifundia) as the main or only parameter to evaluate the results. Under this very narrow perspective, the Brazilian agrarian reform can be considered as a successful program. Extending the definition, and consequently including other parameters to evaluate results, several problems were identified related to life quality conditions, environmental impacts, social organization and governments' action. These problems can be in most part explained and understood based on the historical development of the agrarian reform and regional conditions. The research also includes recommendations to improve the settlement quality and tables comparing single variables (e.g. education, health care, housing conditions, deforestation, productive systems) organized on state, regional and national levels.

Keywords: Agrarian Reform, Brazil, quality of settlement

Equity and Poverty Issues in Watershed Development Projects — A Case Study of Impact Assessment on Marginal Farmers and the Landless

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Participatory watershed development projects have been seen as the solution for the problem of rural resource degradation and poverty alleviation in the past decade. Studies conducted on a large number of projects claim substantial improvements, mostly based on the positive bio-physical indicators as well as the new institutions built during the project. However, there is still no convincing evidence if there has been equity in the distribution of benefits and if they have been successful in alleviating poverty of the most vulnerable sections.

Given this background, the case of Indo-German Watershed Development Programme in Maharashtra in India has been studied in detail to assess the impact on marginal farmers and the landless poor. Following the different components of Sustainable Livelihoods Framework, the watershed concept with special reference to address the issue of equity and poverty alleviation has been studied and necessary methodological issues and indicators to support them for the investigation have been identified. Based on the identified methodological issues, relevant indicators and the institutional approaches in practice, the impact of different measures on selected households of marginal farmers and the landless in the project has been analysed by comparing before and after project empirical data.

Though the overall impact of the project on the livelihood of the people of the project area has been remarkable, there have been significant differences in the benefits accrued between marginal farmers and landless labourers. While the marginal farmers benefited from the improved natural resource base directly by increasing productivity and adopting economically favourable cropping patterns, the landless could not derive their full share of benefits from the project due to lack of access to land. Other institutional building efforts did less to strengthen their voice and bargaining power to articulate their interests. Hence equity and poverty issues could not be addressed effectively. This study, therefore, recommends concerted further research efforts directed towards the implications of promotion of watershed activities under different property regimes and social groups to identify the underlying economic, cultural, social and institutional factors influencing the said equity and poverty issues.

Keywords: Equity, marginal farmers, natural resources, sustainable livelihoods, watershed development

Market Liberalization and the Problem of Instability in Prices and Supply of Domestic Food Grain in Ethiopia

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In Ethiopia, domestic food production is much below the national requirement and has resulted in severe food insecurity problems under almost all governmental regimes. Among several factors causing the problem, inappropriate policy formulation and absence of technological progress were repeatedly emphasized. Thus, Ethiopia has adopted a market liberalization policy since early 1990s in order to stimulate efficient resource use, and the government has withdrawn its market intervention in particularly output marketing trusting that market forces guide and stabilize the economy. In addition, it has been striving to extensively introduce improved technologies to the rural farm households with the primary objective of attaining food self-sufficiency. However, it is argued that fully liberalizing prices has a drawback in that it may result in instability in agricultural production, increasing risk and uncertainty, and that it can worsen food insecurity.

A time-series analysis was made to assess the trend of prices and supply of major food grains. The results indicate that output of food grains dramatically increased from 1994 to 2001 mainly because of the use of improved technologies associated with good climatic conditions; but it drastically fell in 2002/2003. Accordingly, both intra and inter-year price variations were increased in the post reform period. Neither the farm households have storage facilities nor has the government buffer stock facilities to mitigate the instability problem. In addition to the inelastic nature of the supply and demand for grain food, weak governance, periodic weather changes, lack of market information and the absence of storage facilities are among the main causes of the instability problem. Because of the increasing risk of the price and output instability, it was learnt that farmers as well as consumers could not sustainably benefit from the use of improved technologies. Ultimately, the situation has resulted in significant reduction in the use of improved technologies and increasing vulnerability to transitory food insecurity. Therefore, for a sustainable growth in food production and agricultural growth, increasing use of irrigation, improving storage facilities and genuine government intervention to stabilize the grain system, at least in the short-run till the domestic market is sufficiently developed, is greatly recommended.

Keywords: Market liberalization, food insecurity and technological changes, instability

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Migration Dynamics in Ghana — Implications for Migration Forecasts

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The overall aim of this study is to examine the determinants of migration among households in the Volta basin of Ghana at the micro and macro level. To have a complete picture of the movements into and out of the basin, we conducted a survey to obtain information from households that are currently residing outside the basin, but earlier lived within the basin. We interviewed a total of 219 households from the migrant communities in Accra and its suburbs. The main motive for selecting Accra is that migration literature on Ghana indicates that the influx of migration in Ghana is principally to the capital, Accra. Hence, we chose Accra as the survey city to capture movement outside the basin.

It is important for the study to characterize the determinants of migration both at the micro and macro level and further typify the temporary and permanent migrants, for example, what determines one to be a migrant and what selective behavior makes a migrant to move out permanently or temporarily. We have varied data sources to answer these questions. The first data set was collected by the Glowa-Volta team under Common Sampling Frame (CSF). The second data set is on the migrant communities in Accra and its suburbs. The Census data 2000 is the third data source.

To date, basic data on the migration behavior of temporary and permanent migrants in the suburbs of Accra as well as census data have been collected. The census data collected is on the agricultural market prices, rainfall, health facilities, literacy rate, irrigation facilities, population density, distances between major cities of Ghana and the complete matrix of migration flows: all at the district level.

Keywords: Ghana, migration, volta basin

WTO Entry and Agriculture in China

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Based on macroeconomic view this paper practically analyses the chances and challenges in agricultural industries in China after WTO Entry, and meanwhile analyses the essential changes of the market competition of agricultural products in China with impacts of WTO. Based on the analyses, this paper proposes seven countermeasures to WTO challenges for the agricultural industries in China.

The chances of China WTO entry are described in this paper as: China become one constitutor of WTO rules and will get benefit from it. China enjoys the most-favoured-nation clause steadily and the export environment of agro-products is improved markedly. China can use the relative mechanisms to legally protect its rational interests. China can take full advantage of WTO entry to open new development room. China can further enlarge the cooperation with other countries and promote the modernisation of own agricultural production. China will speed up the reform of agro-products circulation system and the development of market economy. The administrative departments will change their functions entirely and enhance work efficiency.

Meanwhile, there are also challenges of China WTO entry, such as: the market competition will certainly take place great and substantial changes, the promises made by China in “Agreement on Agriculture” will also bring strong challenges. The countermeasures against the challenges are proposed in this paper: Optimising resources collocation, speeding up structure adjustment, developing preponderant products; changing subsidy form directly for farmer to reinforce agricultural industries and to enrich farmer; reforming circulation system, standardising market order and exploiting international market; being brave in innovation and carving out thought; adopting standard system, improving product quality and enhancing competition capacity; improving law and rules and using the regulations of WTO to protect own rights and interests; transforming the function of government to enhance macro-control and administrative efficiency.

Keywords: Agriculture, WTO, agricultural market

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Reconciling Sustainability Issues and Environmental Implications of Tropical Cropping Systems

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Forest conversion and land-use change in the tropics are considered the major factors leading to environmental degradation, pollution and greenhouse gas (CO₂, N₂O, CH₄) emissions. The Kyoto protocol promotes a reduction in the emissions of greenhouse gases by about 5 % from 1990 levels by the period 2008 to 2012 in an attempt to mitigate the threat of global warming. Following the green revolution with its emphasis on high fertilizer inputs the development of sustainable cropping systems nowadays is increasingly based on the use of organic residues (alone or in combination with mineral fertilizers) to improve crop production and the soil resource base. In particular the use of legumes has obtained much interest although there has been a shift away from green manures towards leguminous grain legumes in order to increase the impact on farmers' livelihoods. Grain legumes with a low N harvest are particularly beneficial, e.g. promiscuous soybeans, and pose interesting challenges for plant breeders. However, resource use efficiency of legume residues is usually low (10 – 30 %) and considerable losses occur (20 – 60 %) associated with their high quality, poor nutrient release-demand synchrony and high rainfall in humid and sub-humid tropical areas. Although few studies have distinguished between leaching and gaseous losses, investigations from fertilized cropping systems in the humid and sub-humid tropics have shown that N₂O fluxes can be as much as ten times that of natural systems. N₂O emissions are linked to N availability (particularly nitrification) and hence increasing N-rich fast decomposing legumes in cropping systems will contribute to N₂O emissions (e.g. around 0.3 – 2 % of applied residue N can be emitted as N₂O). On the other hand improved soil structure will reduce water-filled pore space and thereby mitigate some of the emission potentials. Zero-till systems, which are being promoted successfully in the Brazilian Cerrados, provide opportunities for carbon sequestration but also a high C availability in the mulch layer favouring N₂O emissions. Thus, the link between sustainability and greenhouse gas emissions is a complex one and the balance between C sequestration, leaching losses and greenhouse gas emission needs to be considered.

Keywords: Cropping system, green house gases, Kyoto protocol, N₂O emission

Long-Term Carbon Input-Output Budget from Organic Fertilisers in Temperate and Tropical Regions

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Soil organic matter (SOM) enrichment by organic fertiliser application is more essential for chemical soil fertility factors in soils of the tropics and for physical soil fertility factors in soils of temperate climates. Even with adequate mineral fertiliser inputs according to crop demand, organic amendments may further enhance the nutrient availability for crops by increasing the cation exchange capacity (CEC) and counteracting P-fixation. The benefit of organic matter on soil physics is related to the formation of organo-mineral complexes that improve aggregate stability. However, SOM enrichment is an investment into a living system that is associated with carbon (C) losses due to respiration of soil microbes. Therefore, the objective of this review was to compare crop yield benefits from organic amendments by quantifying C input-output budgets. Carbon balances were estimated with literature data of farmyard manure (FYM) and pooled data of crop residue and green manure (straw-GM) fertilisation studies from tropical and temperate climates. A direct input-output assessment in five long-term field experiments (40 to 152 years) resulted in an average FYM-C recovery of $33\pm 7\%$ (\pm s.e.) in temperate climates. Based on 171 experiments, additional indirect C budgets were calculated by multiplying fertiliser C accumulation factors (SOC increase / annual C input increase) in soils by relative crop yield responses to increasing SOC levels: In the tropics, $28\pm 6\%$ FYM-C and $13\pm 3\%$ straw-GM-C were recovered in crop yields, which was nearly equal to recoveries of $29\pm 7\%$ FYM-C and $16\pm 4\%$ straw-GM C in temperate climates. These clearly negative C balances of organic fertilisation on cropland have two major practical implications: **(i)** If organic fertilisers are produced in competition with food crops they will reduce the total biomass yield, which is one explanation for frequent crop yield losses in “alley cropping” systems and for lower crop yields in “organic” as compared to “conventional” farming. **(ii)** The atmospheric C mitigation effect is higher by an energetic use of crop residues that replaces fossil fuels than by SOC accumulation on cropland.

Keywords: Alley cropping, carbon sequestration, organic farming, soil organic matter

Biological Control of the Diamondback Moth in Eastern and Southern Africa

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The key insect pest of crucifers in eastern and southern Africa is the diamondback moth, *Plutella xylostella* (L.). Its management with pesticides has become difficult as it has developed resistance to many common insecticides. Farmers increasingly use insecticide cocktails and spray more frequently. In consequence, undesired side effects of, such as environmental contamination, health risks, high pesticide residues in produce and production costs are increasing. To counteract this development, a biological control project covering Ethiopia, Kenya, Uganda and Tanzania was initiated by ICIPE. The indigenous natural enemy complex was studied first. Six primary parasitoids were identified. *Diadegma* spp. and *Itopectis* sp. (*Ichneumonidae*) were prevalent in the highlands, *Oomyzus sokolowskii* KURDJUMOV (*Eulophidae*) an yet unidentified braconid occurred principally in lowlands. Average parasitation rates for these species in 277 fields surveyed in Kenya were 7.6%; 0.8%; 11.2 % and 0.8 %, respectively, 20.8 % in total. A survey of 82 fields in northern Tanzania resulted in 10.1 % parasitism by three species: *D. mollipla* (4.5 %), *O. sokolowskii* (5.4 %) and *C. plutellae* (0.02 %). In order to improve parasitation rates, *Diadegma semiclausum*, a larval parasitoid widely and successfully used in southeast Asia, was introduced to Kenya in October 2001. Field releases were made from mid-2003 in three pilot areas of Kenya and in one in Tanzania. Establishment is recorded from all release areas and parasitation rates by the introduced species have surpassed the combined rate of all indigenous parasitoids. An ex-ante impact assessment predicted a return of 31:1 on the investment in Kenya alone. Additional importations of parasitoids attacking different host stages and adapted to different ecological conditions are planned. The prospects for biological control and the integration of these parasitoids into the pest management system for crucifers are discussed.

Keywords: Biological control, diamondback moth, *Plutella xylostella*

An Analysis of the World Market for Mangos and its Importance for Developing Countries

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Agricultural products are presently still a very significant source of export earnings for developing countries. In the tropics and subtropics, mango represents such an important agricultural product. The objective of this study is to analyse the world market for mangos and determine its importance for developing countries — especially for their welfare — by applying the concept of an interregional trade model. Theory tells and experience shows that participation in world trade and economic development go hand in hand. Open borders and low tariff and non-tariff barriers, ultimately lead to increased foreign trade and eventually increased domestic production. It is the hypothesis of this study that an expansion of export and the reduction of trade barriers have a positive effect on both export revenues and social welfare of developing countries. This will be tested for the case of mango exports from developing countries.

The theoretical part of this paper presents an interregional trade model with a focus on agricultural products in the context of the theorems of RICARDO and HECKSCHER-OHLIN. In the descriptive part an overview of the current situation of the world mango market is given. This includes an analysis of country-specific and regional data on mango production and international trade. Then, a world model for mango shows volumes and structures of all product flows that will minimize the aggregate cost of transportation and production, and determine the pricing system of all products that accompany the optimum allocation system.

The interregional trade of mangos is then simulated in two scenarios. One represents the current situation and the other one simulates a situation with reduced tariffs. The results verify that a reduction of tariffs leads to increased mango production, increased mango trade, and increased aggregated world welfare.

Keywords: International trade, mango market, spatial equilibrium model

Effect of High Temperature on Tomato (*Lycopersicon esculentum*) Genotypes under Controlled Conditions

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Tomato (*Lycopersicon esculentum* MILL.) is usually produced during the winter period in Sudan. In summer due to high temperatures, monthly average temperatures are between 31 to 35 °C, a shortage of tomatoes is common. General environmental changes, especially global warming, may have an adverse effect on crop production in Sudan.

The objective of this study is (i) to investigate the effect of heat stress on vegetative and productive development of heat sensitive and tolerant tomato genotypes, (ii) to compare the growth and development of different genotypes under defined heat stress conditions (intensity and duration) as well as (iii) to investigate if there are any positive effects of grafting or heat shock treatments to increase heat tolerance of tomatoes. Different experiments were carried out under simulated temperature conditions in plant growth chambers at the Humboldt University of Berlin as well as under field conditions at the University of Khartoum, Sudan. Here only results obtained from experiments under controlled condition are presented. Plant high, leaf area, fresh and dry weight of leaves, stem and roots, number of clusters, number of flowers, number of pollen grains per flower as well as assimilation and transpiration rate were recorded. The reproductive processes in tomato were more sensitive to high temperatures than the vegetative ones. The number of pollen grains produced by the heat tolerant genotypes, were higher than the numbers produced by the heat sensitive genotypes. Night temperature had a significant effect on the number of pollen grains produced and released. Additionally heat tolerant genotypes showed higher photosynthetic rate at flowering stage compared to the heat sensitive one. Preliminary results in this study suggest that photosynthetic rate at heat stress condition could be used as criteria for screening genotypes for heat tolerance.

However, under field condition in Khartoum, Sudan other factors such as low relative humidity, insect and virus diseases as well as soil physical properties have also to be considered. Optimization of microclimate could be very important to ensure a good performance of new tolerant varieties cultivated in summer periods in Sudan.

Keywords: Heat stress, photosynthetic rate, pollen grains, Sudan, summer period, tolerant genotypes, tomato

Optimal Crop Combinations under Limited Resource Conditions — Application of Linear Goal Programming Model to Smallholder Farmers in the Drier Savannah Zone of Nigeria

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Smallholder farmers in the drier savannah of Nigeria have multiple goals and operate under limited resource conditions for both crop and livestock production. In most cases, the goals of providing food for the family throughout the year, accumulating monetary income and ensuring minimum use of paid labor are paramount. Therefore, this paper seeks to identify the optimal crop combinations and to analyze the resource allocation patterns of crop farmers in the drier Savannah zone of Nigeria. This is with the view to suggesting an optimal crop enterprise combination that will meet the aforementioned goals of a farm family.

Using data collected from 400 farm households selected in the rural areas of Kebbi State, in the drier Savannah agro-ecological zone of Nigeria, we applied a Linear Goal Programming (LGP) technique to model farm-family crop production enterprise. Through this, optimal crop enterprise combination that would enable smallholder farmer meet the most important goals was identified. Results from the goal programming revealed that only mix cropping enterprises are feasible. Among the 18 enterprises identified, only four enterprises are feasible. All four are cereal-based. These activities and their hectare allocations were Millet / Maize / Rice (1.20 ha), followed by Maize / Guinea corn / Cowpea (0.94 ha), then by Millet / Cowpea (0.16 ha), and by Maize / Cowpea / Millet (0.04 ha). The minimum cost of this plan is N 6485.16 per hectare. The result further revealed that some household resources such as land were in excess of actual household requirements. This suggests that land is not yet the constraining factor among the farmers. However, effective farm advisory services on the efficient allocation of farm resources are important and should be built into programs promoting increased agricultural productivity among farmers.

Keywords: Drier savannah, linear goal-programming, Nigeria, optimum crop combination, smallholder farmer

Increase in the Importance of Ethiopian Pepper Mottle Virus in Hot Pepper Production in the Rift Valley Part of Ethiopia — Time to Create Awareness among Farmers and Researchers

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Hot pepper (*Capsicum annuum*) is an economically and traditionally important crop in Ethiopia. In addition to its export value, the powder form the dried pod is the main component in the daily diet of Ethiopians. Districts such as Awassa, Alba, Ziway, Marko, Boditti, Humbo, Meki, and Koka in the rift valley parts are the major producing areas of the crop. In these areas, hot pepper serves additionally as income generating crops for off-farm activities of farmers particularly in the time of cereal deficit.

Observation showed that the production of the crop has been banned in some years due to unacceptably high proportion of viral infection. In order to determine and verify the identity of viruses involved, 400 samples collected from framers field in 2001/2001 cropping season were subjected to different virus identification methods. The result revealed that 60 % and 10 % of the samples were infected by EPMV alone and in mixed infection with the other potyviruses respectively.

In order to further undertake applied investigations and reaffirm the results, biological and serological properties of EPMV were well established. Then, for routine analysis of more samples antiserum against a sever strain, designated as EPMV-bod3 was produced. Using this antiserum, 450 samples of hot pepper in the 2002/2003 cropping season were analysed with DAS-ELISA. The results revealed that 78 % of the samples were infected with EPMV, confirming its importance in the region.

EPMV has been found to be endemic to Ethiopia. Although information on aspects of virus-vector relationship under field conditions are still lacking, the conducted studies revealed that EPMV has many natural reservoirs in the region. In addition, farmers grow very viruses susceptible varieties. Interviews with farmers also indicated a lack of knowledge concerning the cause of their crop losses. Trained extension workers in the field of plant virology who can help farmers in virus diagnosis are lacking. Combinations of these factors have contributed to the increasing importance of the virus in the region. It is high time, therefore to make farmers aware of their problem and to devise suitable management measures against the virus.

Keywords: Hot pepper, EPMV, farmers, rift valley parts of Ethiopia

Cassava Leaf Harvesting as Vegetables — A Cause of Vulnerability of the Crop Plant to Cassava Mosaic Disease and Eventual Yield Reduction

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The consequence of harvesting young leaves of cassava as vegetable on the vulnerability of the crop to cassava mosaic disease (CMD) and on storage root yield was investigated using 30 cassava genotypes planted in IITA fields located in the humid forest (Port Harcourt: Onne), forest-savannah transition (Ibadan), southern guinea savannah (Mokwa), northern guinea savannah (Zaria) and sudan savannah (Mallam-Madori) agroecologies in Nigeria. Tender apical leaves and shoots of the cassava genotypes were removed on forty plants with the same number of plants as control for each genotype. The treatment effect on vector whitefly infestation, disease incidence (DI) and symptom severity (ISS) of the disease was assessed monthly for six months and also at the ninth month after planting (MAP). Yield reduction due to this treatment was calculated as percentage harvest index (HI). Whitefly infestation was remarkably higher on plants subjected to this treatment than on control plants on all the genotypes. There was a significant treatment effect ($p < 0.01$) on DI and ISS on genotypes 96/0191, TMS 30572, 96/0035 and 4 (2)1425 in all the locations. Significant differences ($p < 0.01$) in DI and ISS were observed among cassava genotypes throughout the period of observation in all locations. There was positive correlation between DI and ISS on plants of genotypes 96/1039 and ISU. The percentage HI values on treated plants were remarkably lower than the values calculated for the control plants at all locations. Harvesting tender apical leaves and shoots of cassava as vegetables should be discouraged as it increases the severity of CMD infection in the regenerating shoots of cassava with attendant storage root yield reduction.

Keywords: Cassava genotypes, cassava mosaic disease (CMD), disease incidence, harvesting of cassava leaves, symptom severity, harvest index (HI)

Effects of Straw Management on Soil N Dynamics During the Dry-to-Wet Transition Period in Rice Based Systems

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In the seasonally wet tropics, alternating soil drying and wetting cycles characterise the dry-to-wet season transition period (DWT) after the harvest of the dry season crop and before the transplanting of wetland rice. Large soil N losses during DWT have been shown to occur from lowland fields in Asia and Africa. Particularly under low-input conditions, this native soil fertility needs to be conserved for crop (lowland rice) production. Previous field experiments have shown that native soil N losses during DWT can be minimized through the temporary N immobilization in the microbial biomass after application of low quality crop residues (e.g., cereal straw). While soil N conservation may potentially benefit the subsequent crop of rice, too much straw may lead to N immobilization for longer than desired, resulting in yield reduction. The effect of different rates and methods of straw application during DWT on soil N dynamics has been studied under controlled conditions in a greenhouse. Wheat straw at rates of 1.5, 3.0 and 6.0 Mg ha⁻¹ has been either incorporated or applied as surface mulch. Soil moisture was gradually increased from 50% field capacity to full water saturation during DWTs of varying lengths. The dynamics of soil N_{min}, soil microbial biomass N and *in situ* N₂O emissions were quantified at weekly intervals. The growth and N uptake by a subsequent crop of lowland rice was evaluated. Implications of various straw management options on the N nutrition of wetland rice will be validated in participatory on-farm experiments in rice-wheat rotation systems in South Asia.

Keywords: Denitrification, microbial biomass, N-immobilisation, *Oryza sativa*

The Efficacy of Resistance Inducing Agents for the Control of Sunflower Broomrape (*Orobancha cumana*)

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The resistance inducing product BION® (Syngenta) has been demonstrated in triggering defence reactions in crop plants against bacterial, fungal and viral pathogens but also against parasitic weeds of the genus *Orobancha*. In this study, pot experiments were conducted under greenhouse conditions to evaluate the efficacy of different concentrations of BION and other resistance inducing agents in order to control *Orobancha cumana* in sunflower.

The elicitors were applied on sunflower plants (cv. HA 89) grown in pots (13 × 13 × 13 cm) as soil drenching three times in intervals of 14 days. Evaluation of disease incidences as well as biochemical analysis were conducted as described elsewhere. BION applied in a concentration of 10 mg a.i./pot resulted in a complete inhibition of infestation of sunflower roots with *Orobancha cumana*. However, it reduced as well the weight and size of the sunflower heads of about 70 % in contrast to non-diseased and untreated controls. BION in 2 and 5 mg a.i./pot controlled about 83.2 % and 86.9 % of total number of *O. cumana* at the first trial, respectively and in 2.5 mg a.i./pot controlled about 54.2 % at the second trial. In these concentrations no significant effect on sunflower head size was observed.

With the exception of the chemical dichloro-isonicotinic acid (DCINA) none of the other 14 resistance inducing agents had an effect on the infestation with *O. cumana*. DCINA applied in 3 and 10 mg/pot reduced the total number of *O. cumana* by 65.5 % and 100 %, respectively. However, the development of sunflower heads was completely inhibited.

The results show that the commercially available resistance inducing agent BION is able to reduce infection with *O. cumana* when applied as soil drench. Applied in low concentrations the compound even does not reduce the productivity of the crop. This control method can be significant part in integrated management of the parasitic weeds of the genus *Orobancha*.

Keywords: BION, induced resistance, *Helianthus annuus*, *Orobancha cumana*

Spatial Variability of Indigenous Nutrient Supply for N, P and K and Impact on Fertilizer Strategies for Irrigated Rice in the West African Sahel

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Even with optimal crop management, spatial variability of indigenous nutrient supplies combined with uniform fertilizer recommendations for large regions can cause low fertilizer efficiency, low productivity of expensive inputs and high losses to the environment. Substantial efficiency increases were achieved with site-specific nutrient management approaches, but the relative importance of different components (field, region or season specific precision) remained unclear. We conducted a field trial to investigate small-scale variability of indigenous nutrient supply of N (INS) P (IPS) and K (IKS) on a three hectare farm and used the field data in subsequent simulation scenarios to analyze the agro-economic effects of fertilizer management with different precision levels.

Spatial variability of soil characteristics and of IS on the small area analyzed was high and covered a large part of the variability found in regional studies within the Senegal river valley. INS ranged from 19 to 78 kg N ha⁻¹, IPS ranged from 11 to 45 kg P ha⁻¹, and IKS ranged from 70 to 150 kg K ha⁻¹. This caused yield ranges of 2.2 to 6.0 Mg ha⁻¹ in N omission plots, of 4.1 to 9.8 Mg ha⁻¹ in P omission plots, and of 5.3 to 9.6 Mg ha⁻¹ in K omission plots. The highest yield in the fully fertilized treatment was 11.6 Mg ha⁻¹. Simulated potential yield was 11.8 Mg ha⁻¹. Simulations of fertilizer management scenarios were based on observed IS, observed average recovery rates, and potential yield. Scenarios ranged from high precision and season specific fertilizer doses to the existing regional recommendation for average seasonal yield potentials. Highest precision and an economically optimal target yield resulted in an average yield of 9.6 Mg ha⁻¹ compared to 7.5 Mg ha⁻¹ for the uniform recommendation. Net benefit from fertilizer use dropped by 19%. Highest losses of optimal net benefit were related to non-season specific recommendations (12%), whereas lower spatial precision contributed only 7% to the net benefit loss. We concluded that uniform regional recommendations for agro-ecological zones modified by crop diagnostics offer the best opportunities to optimize fertilizer efficiency and net benefits of fertilizer use in intensive irrigated rice.

Keywords: Indigenous nutrient supply, irrigated rice, site specific nutrient management, spatial variability, West Africa

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Impact of High Temperature and Drought Stress Induced at Different Growth Stages on Flowering Phenology of Three Maize (*Zea mays*) Varieties

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Growth and flowering patterns of three Ethiopian maize varieties (viz. A-511, ACV-6 and Katumani) were tested at five different soil-moisture regimes (i.e., no drought stress throughout the growth - control, and soil-moisture stress induced at one week before tasseling, at silking, at grain filling, and throughout the growth). The study was carried out under field conditions (in Ethiopia) and in a greenhouse (Thailand). Mean daily air temperatures in Ethiopia were 21°C and in Thailand 28°C.

Under field conditions, the drought-stress regimes significantly modified the flower development of all tested varieties when compared to the control. Moisture deficit throughout the growth period prolonged the time to tasseling ($p < 0.01$). This shortened the interval between tasseling and silking (TSI) ($p = 0.01$). On the other hand, drought stress induced at one week before tasseling delayed silking ($p < 0.001$) without an affect on the time to tasseling. This widened the TSI by 36 % ($p = 0.016$).

In the greenhouse study, induced drought stresses at different growth stages did not show significant differences in flowering. However, the overall average days to tasseling and silking were reduced by 18 % and 22 %, respectively, while the average TSI of the three varieties increased by 47 % compared to the experiment conducted under field conditions. In the greenhouse, the cumulative heat-unit requirement in terms of growing degree-days (GDD) showed an increase of 9 % for tasseling and 15 % for silking. The general thermal index (GTI) showed changes of 9 % for tasseling and -1 % for silking.

The response of the three maize varieties to drought stress — due to the changes in temperature — was significantly different in respect to the time to tasseling and silking, and the required average heat units for flowering. These are critical determinants of grain yield of maize.

Keywords: Flowering pattern, growing days, Ethiopia

***Tetranychus evansi* in Africa — Status, Distribution, Damage and Control Options**

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The tomato red spider mite *Tetranychus evansi* BAKER and PRITCHARD is of South American origin and was found for the first time in continental Africa on tobacco in Zimbabwe in 1979. It is specialized on Solanaceae and is currently the most important dry season pest of tomatoes in southern Africa. However, it has never been identified correctly from this host until 1998. Currently it is known to occur in South Africa, Namibia, Mozambique, Zimbabwe, Zambia, Malawi, Kenya, Democratic Republic of Congo, Somalia, Morocco and Tunisia. Densities of more than 1500 motile *T. evansi* on the three terminal leaflets of tomato leaves have been found in experimental fields in Zimbabwe and yield losses of up to 90 % have been recorded from field trials. Most indigenous natural enemies do not feed on *T. evansi*. Control with acaricides often fails in African small-holder environments due to the lack of proper equipment and application techniques. Field experiments in Zimbabwe showed that pruning and staking of tomatoes increases the efficiency of acaricide applications, reduces mite populations and significantly increases tomato yields. A second strategy to control *T. evansi* is classical biological control. Surveys on natural enemies have been started in the mite's probable area of origin in north-eastern Brazil in 2000. So far, 14 species of predatory mites and a predatory gall midge (*Cecidomyiidae*) have been identified as potential candidates for introductions into Africa. Investigations into the biology of several candidates are currently ongoing and the first releases in Africa are planned to start in 2005. The third control strategy is host plant resistance. Laboratory screening of more than 280 accessions of cultivated tomato and its wild relatives has revealed 13 accessions where mite reproduction is greatly reduced. Investigations on resistance mechanisms and field trials to confirm the resistance are currently in progress.

Keywords: Africa, biological control, integrated pest management, spider mites, *Tetranychus evansi*

Developing a Standardised Procedure to Screen Lowland Rice (*Oryza sativa*) Seedlings for Tolerance to Iron Toxicity

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Despite a rapid expansion of cultivated lowlands, rice production in West Africa lags behind consumption. Among numerous yield-limiting factors, iron toxicity is one of the dominant production constraints on the Ulti-, and Alfisols in the humid zone of the region, accounting for yearly yield losses of about 50,000 tons of paddy. The use of tolerant rice cultivars is seen to be the most effective means to address Fe toxicity. However, current varietal development in Asia and West Africa provided few transferable results (i.e. Fe-tolerant cultivars or breeding lines). Thus, supposedly tolerant cultivars from Asia succumbed to Fe-stress in West Africa and vice versa. Controlled and standardized experimental conditions producing repeatable results are required for varietal screening procedures particularly at seedling stage. A series of phytotron experiments were conducted to establish and test such a standard screening tool. Concentrations of 0–3000 ppm Fe ($\text{FeSO}_4 \cdot 7 \text{H}_2\text{O}$) were applied to two and four week-old seedlings of known Fe-tolerant (Suakoko-8) and Fe-sensitive (IR317) check cultivars. Rice seedlings were planted in 1 % slant agar, prepared from Yoshida culture solution with different strengths. The 330 ml plastic pots were filled with solution medium and covered with paraffin oil to maintain anaerobic conditions. Different levels of vapour pressure deficit (air humidity of 60–65 %) were used in the phytotron. An additional set of Fe-tolerant and sensitive rice varieties from Ghana was used to validate the set-up. Expression of leaf bronzing symptoms was scored between one and four days after Fe addition and dry biomass and Fe content in shoot were determined. In both two and four week-old rice seedlings, a leaf-scoring three days after applying 2000 ppm Fe II provided the best visual differentiation of the test cultivars. Increasing the vapour pressure deficit from 60 to 65 % air humidity in the phytotron tended to increase leaf iron uptake in the sensitive cultivar. Plotting the iron content in the leaf tissue against the leaf bronzing score allowed for a differentiation of cultivars into sensitive, tolerant inclusions and tolerant excluders. It may be concluded that the proposed culture set-up allows within three days of Fe II addition to two and four week-old rice seedlings to reliably differentiate tolerant from susceptible cultivars. A validation using a wider range of cultivars and breeding lines and further studies on the effect of the vapour pressure deficit are required.

Keywords: Fe-toxicity, rice breeding, Ghana

Variation in Fruit Quality of Different Salak Genotypes (*Salacca zalacca*) from Indonesia

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Salak fruit is called “snake fruit” due to the appearance of the fruit skin, which resembles to the structure and colour of a snake skin. It is a small drupe (about 5 cm in diameter) with an aromatic and sweet flavour.

In Indonesia, salak has been cultivated across the islands and used as a food source for a long time ago. Among about 22 cultivars of salak, “pondoh” is the most promising because of its superior quality. In order to enter the worldwide market, the knowledge about post-harvest quality of the fruit is a very important aspect.

The purpose of this study was to investigate the nutritional valuable compounds, e.g. dietary fibres (pectin, lignin, hemicellulose, cellulose) and carbohydrate fractions (fructose, glucose, sucrose) of 4 different salak cultivars, i.e. “Pondoh Super”, “Pondoh Hitam”, “Pondoh Manggala” and “Gading Jawa”. These compounds were related to quality attributes of the fruit and provide information on physiological and textural properties of salak.

Total dietary fibres (insoluble dietary fibre and pectin) of “Gading Jawa” was the highest (93.5 mg/g dry matter (DM)) followed by “Pondoh Super” (69.7 mg/g DM), “Pondoh Hitam” (63.3 mg/g DM) and “Pondoh Manggala” (63.3 mg/g DM), respectively. Salak Pondoh tended to contain more crude fibre and hemicellulose (which varied from 19.6–22 mg/g DM and 4.1–7.2 mg/g DM, respectively) than those of “Gading Jawa” (18.2 mg/g DM and 3.9 mg/g DM, respectively). No significant differences of pectin content were found among all 4 salak cultivars, except the water-soluble pectin fraction of salak pondoh (which varied from 12.8–15.8 mg/g DM) being higher compared with that of “Gading Jawa” (9.88 mg/g DM). On the other hand, total carbohydrate of “Pondoh Hitam” was the highest (734.83 mg/g DM) followed by “Pondoh Manggala” (719.51 mg/g DM), “Pondoh Super” (687.23 mg/g DM) and “Gading Jawa” (652.92 mg/g DM), respectively. The high values of the dietary fibres and carbohydrate fractions reflected not only the high nutritional value, but also the sensory and textural quality compounds which will be discussed in detail.

Keywords: Nutritional value, Salacca

Potassium Management for Irrigated Lowland Rice on Degraded Soils in the Red River Delta of Vietnam

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The Red River Delta of North Vietnam is among the most densely populated rural areas in the world, averaging 1000 inhabitants per km². Land holdings are small, resulting in highly intensive agricultural practices and the extensive use of external inputs. Three to four crops per annum are cultivated in a single field with rice as the predominant species. The research presented here, focused on degraded soils that occupy about 20 % of the total cultivated area. Low inherent nutrient supply and organic matter contents characterize those soils that developed on old alluvium along the fringes of the Delta. Light soil texture and low nutrient holding capacity call for new approaches in potassium management in order to improve the efficiency of application and consequently the financial return of the cash poor farmers living in the area.

It is current practice that all straw is removed from the field after harvest, resulting in large K exports. Straw is used as animal feed and bedding, as well as fuel for cooking and part is returned to the field as farmyard manure. The sustainability of current fertilizer practices was assessed through nutrient balances in a long-term cropping system experiment. Nutrient availability was measured with resin capsules during the period of highest uptake by rice. Results indicate NPK availability in high to medium range and positive effects of residue incorporation.

It was hypothesized that due to the sandy nature and low CEC of the soils large leaching losses of K are likely to occur. Initial results indicate that a split-application of K results in significant higher rice yields in the wet season. A late K application at flowering tended to improve grain filling and also increased yields. However, during the dry season, when the yield potential is higher than in the wet season, no response to K fertilizer application was observed. The causes for this are currently investigated. It is suggested the K supplied by irrigation water was sufficient to attain the current yield level of 5.5 Mg ha⁻¹. Magnesium and micronutrient deficiencies could then be the main yield-limiting factors during the dry season.

Keywords: Leaching, maize, nutrient balances, nutrient uptake, *Oryza sativa*, residue incorporation, rice straw, soybean, split application

Rice Cropping Systems and Possibilities for their Improvement in Myanmar

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Rice (*Oryza sativa* L.) is by far the most important staple for the 48 million people in Myanmar (formerly Burma) of whom 75 % directly depend on farming. National average grain yields of 2.8 t ha⁻¹ are relatively low and little is known about the actual inputs used and constraints limiting rice productivity in this country. To identify yield constraints, input intensities and general practices of rice cultivation in Myanmar, an on-farm survey was conducted in 2001 and 2002. Six townships of lower Myanmar and three townships of upper Myanmar were selected. They represented the most important areas of rice production with approximately 80 % of the national rice output. A subset of these sites and a few additional sites were revisited in 2002 to verify the results obtained in the previous year. The survey included five to six randomly selected farmers per site who grew the popular rice variety Manawthukha. These farmers were interviewed using structured questionnaires comprising questions on soil fertility, observed diseases, and their socio-economic status. In addition each field was assessed for incidence and severity of diseases and pests. Plant sampling occurred at the end of the season (November) to determine straw and grain yields. The results revealed that irrespective of farm size about 65 % of the rice was grown under rainfed conditions. Around 90 % of the farms < 2 ha and 70 % of the farms with a farm size of > 2 ha used rice double cropping. Three rice crops per year were only grown on larger farms. The use of mineral fertilisers increased and pesticide use decreased with farm size. Only about 18 % of the farmers applied herbicides, but 71 % used fungicides and/or insecticides. Very few insect pests were observed in the fields. Most widespread (with highest incidence) and severe was sheath blight (*Rhizoctonia solani* KÜHN). However, if bacterial leaf blight (*Xanthomonas oryzae* pv. *oryzae*) and sheath rot (*Sacrocladium oryzae*) occurred, their incidences were often high. A surprisingly high incidence of false smut (*Ustilaginoidea virens*) was found in two fields, but it remains open to further investigation under which conditions this disease may cause epidemics in Myanmar.

Keywords: Cropping systems, field survey, rice diseases, Southeast Asia

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Occurrence of Millipedes by Example of *Spinotarsus caboverdus* on Cape Verde

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The species *Spinotarsus caboverdus* has been falling into disrepute for 20 years as a pest of many plants which are important for the food of the inhabitants of the Cape Verde. *S. caboverdus* is an example of diplopods that was spread by people through trading. It does not only live on all kinds of vegetal waste materials, but also attacks crop plants like potato, pumpkins, tomatoes, cassavas, melons, ripe strawberry, cabbage, germinating beans and corn. The species *S. caboverdus* prefers fruits like papayas, mangos, bananas and pineapple and heavily damages them due to its massive presence.

Through laboratory breeding and field investigations we can answer some questions about millipede reproduction processes and life cycle. We were able to ascertain that the species *S. caboverdus* produces one generation per year on the Isle Santo Antao. Adults are present throughout the whole year but the maximum number of them seems to be in June, July and August. Under lab-conditions adults can live up to 8 months. In this time they are frequently changing their place to find food plants and best conditions for reproduction. During the first four phases the juveniles remain in the ground and use mainly dead organic matter as food. The later juvenile stages can also be found on plants in or on the soil's surface. The whole development of the juveniles takes 7 months.

This pest is problematic due to the high population density. *S. caboverdus* uses very well the ecological conditions of the island to its advantage. The mountainous character of the island Santo Antao with its humid microclimate is especially suited for the preservation of the species during the dry season. The traditional irrigation system forms optimal conditions for reproduction and early development. Thus, they reach a high reproduction rate and through the strong mobility we find a permanent spread of the species. In addition to this, Millipedes have few predators or parasites on Cape Verde which can effectively control density of their population. These circumstances are the reason for a constant high population density across the island Santo Antao since its first detection in 1987.

Keywords: Cape Verde, Millipedes, traditional migration system

Nitrate Reductase Activity in Rice as Related to Weed Competitiveness

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Traditional and improved rice cultivars (*Oryza sativa* L.) belonging to two groups of Asian rice (japonica-upland and indica-lowland), were studied for weed competitiveness. Rice was grown under controlled conditions in hydroponics using a modified Yoshida nutrient solution. As an indicator for weed competitiveness we used the activity of the enzyme nitrate reductase (NRA) which allows the rice to take up nitrogen under aerobic upland conditions. NRA of the 4 rice genotypes was tested under different nitrogen nutrition regimes representing upland (40 ppm of NO_3), lowland (40 ppm NH_4) and hydromorphic (20 ppm NH_4 and 20 ppm NO_3) rice cropping systems.

Rice varieties appeared to be adapted to the ecological conditions for which they were selected. The upland adapted genotypes showed higher NRA under NO_3 nutrition and little NRA with NH_4 nutrition whereas the lowland adapted varieties showed relatively low NRA with both NH_4 nutrition and NO_3 nutrition.

Improved lowland types showed low NRA when grown in either NH_4 or NO_3 mediums, however very high levels of enzyme activity were observed for improved upland adapted types.

Lowland weed types such as *Echinochloa crus-galli* and *Crotalaria* spp. show limited NRA under NH_4 or NO_3 nutrition, with slightly higher activity observed when the medium contained both NO_3 and NH_4 . Those weeds adapted to upland conditions such as *Euphorbia heterophylla* and *Zea mays* showed relatively high NRA in NO_3 medium as compared to NH_4 . However, in all cases the NRA of the traditional rice cultivars was higher than that of the weeds. The NH_4NO_3 treatment resulted in highest NRA for the broad leafed weeds, while the narrow leafed varieties responded to NO_3 treatments. All enzyme activity was measured in vivo in leaf tissue. In all cases, higher NRA resulted in greater accumulation of plant biomass indicating better nutrient acquisition efficiency. This study concludes that it is possible to relate leaf NRA to plant biomass accumulation, giving NRA the potential of a screening tool for weed competitiveness in rice.

Keywords: Enzyme activity, rice cropping systems, screening, selection, upland weeds

Optimizing Agricultural Product Utilisation from Small-Scale Farm Production — The Case of Neem in Sudan

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The small quantities produced, personnel capacities, uncertainty and risk faced by the rural households usually limit the marketing range of the surplus production in developing countries. Some of these products are highly demanded on national and international markets but cannot be channelled into these markets because of missing or inappropriate marketing schemes. Various approaches in the past were developed under the prerequisite of large production schemes and quasi-monocultural environments. These approaches do not meet the requirements for the utilization of agricultural products from Small-Scale Farm Production.

The presented study has investigated the opportunities and worked out a methodology to assist in planning and setting up marketing schemes for the utilization of widely distributed already available farm products from small-scale farm households on the case of Neem in Sudan. The study incorporates environmental, economical and social determinants and their spatial distribution optimizing a marketing scheme in order to benefit a private sector company, demanding the product and carrying out the investment as well as the producers, owning and supplying the agricultural products. The model rests basically on the supply demand equilibrium. This equilibrium is extended by spatial and environmental determinants on both sides of the equilibrium equation. The supply and demand meet locationally in Collection Centres which are satellite stations spatially distributed depending on the potential production in certain areas. The different characteristics of the supply and the demand assign an interface function to the collection centres joining a modern economy favoured by the company and a traditional economy favoured by the farm households. Furthermore, the collection centres have to fulfil a buffer function smoothing the seasonal supply by the producers and the continuous demand from the company. The only way to fulfil this buffer effect is the decentralization of the production line through the company.

Keywords: Marketing, neem, planning, small-scale farm, Sudan

Cotton-Basil Intercropping — Effects on Pest Infestation, Yield and Economical Parameters in a Biodynamically Managed Field in Fayoum, Egypt

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In many countries, cotton is traditionally intercropped with other plants in order to increase yields and control pests. We tested the effects of intercropping cotton (*Gossypium barbadense*) and basil (*Ocimum basilicum*) on pest infestation, yields, and economical parameters in the Governorate of Fayoum, Egypt. Basil, which is known for its repellent effect on various insect pests, was mixed with cotton in three different area fractions (no medium and high basil fraction) and two row distances (60 and 90 cm) using a substitutive design. Compared to the non-intercropped plots, cotton-basil intercropping significantly reduced total pest infestation and led to a 50 % reduced abundance of the pink bollworm (*Pectinophora gossypiella*). Our data also show that basil affected the movement and abundance of the beneficial epigeic fauna (e.g., *Coleoptera*, *Araneae*, *Gryllidae*, *Salientia*) into the cotton areas: abundance of the epigeic fauna was 30 % higher in the neighborhood of adjacent basil strips than in the centre of the cotton plots. Since neither basil intercropping nor different row distances affected microclimatic parameters in the experimental plots, we assume that both a basil-induced repellence against pest insects and a stimulation of beneficial epigeic fauna might be responsible for the lower pest infestation in intercropped plots. No correlation between pest infestation and cotton yields could be detected. Despite an up to 33 % reduced area of cultivated cotton in the intercropped plots, seed cotton yield was not affected by intercropping. A wider row distance significantly reduced the number of cotton bolls per area, however increased boll mass and cotton yield per plant thus resulting in similar seed cotton yield per hectare than with narrow row distance. A wide row distance also increased the abundance of spiders and crickets, however did not affect weed abundance. With the exception of the treatment “intercropping with low basil fraction and wide row distance”, intercropping resulted in higher total revenues and gross margins compared to single cotton cropping. Our results demonstrate the high potential of intercropping cotton with basil in order to achieve a reduced pest infestation while concurrently increasing gross margins.

Keywords: Cultural pest control, *Earias insulana*, *Gossypium barbadense*, mixed cropping, *Ocimum basilicum*, *Pectinophora gossypiella*

Fixation and Release of Ammonium in Paddy Soils after Flooding

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Poor utilization of N fertilizers by rice plants seems to be largely due to N losses from the soil plant system and through denitrification, leaching, runoff and NH_3 volatilization. Therefore, the primary aim of improved N management is to minimize transformation processes that result in N losses and to maximize N uptake. One important transformation process, which leads to a temporary immobilization of fertilizer N as well as of NH_4^+ from the deamination of organic N compounds, is the fixation of NH_4^+ ions by 2:1 clay minerals. However, factors which may have an impact on fixation and release of ammonium in paddy soils are still poorly understood. It is assumed that NH_4^+ fixation might be promoted by the decreasing redox potential in flooded soils, because of the reduction of structural Fe III, causing an increase of the negative charge of certain clay minerals. However, since rice plants are able to secrete O_2 into the rhizosphere, which may oxidize Fe II to Fe III, it seems possible that the release of fixed NH_4^+ might be promoted by rising the redox potential in the vicinity of the roots.

A series of model experiments were conducted to establish the effect of O_2 secretion from imitated rice roots on the availability of non-exchangeable NH_4^+ and N uptake by imitated rice roots under flooding conditions. The soil was flooded and incubated at 30°C. A special apparatus was used to imitate O_2 secretion and N uptake by rice roots. A PVC pipe sealed with a nylon net at one end was inserted into the soil. One week after flooding air was pumped into the PVC pipe by a gas dispenser to imitate O_2 secretion from rice roots. To simulate N uptake a nylon net bag filled with an ion exchange resin mixture was placed in the PCV pipe. Results on the influence of the redox potential on the fixation and release of NH_4^+ and N uptake will be discussed.

Keywords: N-utilisation, redox potential, rice

Investigation of Pathogens for Biological Control of Parthenium Weed (*Parthenium hysterophorus*) in Ethiopia

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Parthenium is an exotic invasive annual weed believed to be introduced to Ethiopia in 1970s and has currently spread to the most part of the country. An exploratory field survey and laboratory studies on pathogens associated with parthenium was studied from 1998 to 2002 in order to provide information on future implementations of biological control in an integrated parthenium management.

A number of fungal isolates were obtained from seed and other plant parts of parthenium weed of which putative pathogenic fungal isolates were species of the genus *Helminthosporium*, *Phoma*, *Curvularia*, *Chaetomium* and *Alternaria*. The two most important diseases associated with parthenium were the rust caused by *Puccinia abrupta* DIET. & HOLW. var. *parthenicola* (JACKSON) Parmelee and the phyllody caused by Faba Bean Phytoplasma Group (FBP). The rust was commonly found in mid altitude (1500–2500 m) with incidence from 5 to 100 % while phyllody was observed in low to mid altitude regions (900–2300 m) of Ethiopia with incidence of 5–75 %.

The individual effects of the rust and phyllody diseases on parthenium weed morphological parameters and seed production capacity showed that the rust disease reduced mean plant height, number of leaves per plant, leaf area, number of branches, dry matter yield at maturity and number of seed produced by 11 %, 22 %, 28 %, 13 %, 25 %, and 43 %, respectively. On the other hand, phyllody disease significantly reduced mean plant height, leaf area and seed production by 29 %, 81 %, and 85 %, respectively.

Phyllody phytoplasma and *Puccinia abrupta* were successfully infecting parthenium weed in many infested areas of Ethiopia with significant reduction on morphological parameters and seed production in the field. Hence, they are potentially useful as components of integrated parthenium management after further confirmation of insect vectors that transmit phyllody, and of host range of phyllody disease to related economic plants in Ethiopia.

Keywords: Biological control, parthenium, phyllody, rust

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Effects of Cropping Intensity on Rice Production in Myanmar

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In the Southeast Asian country of Myanmar population pressure presently leads to a widespread intensification of the irrigated rice production through increased application of mineral nitrogen (N), higher cropping frequencies and the use of modern, high yielding cultivars. To determine the effects of such changes in the production system on the sustainability of rice production, a multi-factorial soil fertility experiment was established in early 2001 at two contrasting field sites. The objectives of this project were (i) to identify the yield constraints and N use efficiency in paddy rice, (ii) to understand the causes and site-specific variation of these constraints and (iii) to develop management strategies to overcome such constraints to increased rice production based on a holistic understanding of the soil-plant continuum. Three cropping sequences were established representing different intensities of rice cultivation: rice double cropping with fallow, rice double cropping with a legume (black gram, *Vigna mungo* L.) in the third season and rice triple cropping. Fertility treatments were 2 t ha⁻¹ straw or the equivalent in ash combined with 40 to 120 kg N ha⁻¹ in various split application schemes. Increased application of N led to increased disease incidence, but these effects were site-specific and likely reflected more complex interactions with soil properties. Overall, disease pressure was higher at Hmwabi in southern Myanmar (2300 mm annual rainfall; clayey loam) than at Yezin in the upper part of the country (1310 mm; sandy loam) but fertility treatments increased the pressure only at Yezin. Treatments-induced differences in rice yield varied greatly between sites with immediate yield increases following N addition at the more sandy site of Yezin in central Myanmar. At the Hmwabi site with higher rainfall, however, straw addition seemed to hamper the effects of N at low levels. Overall, there was no difference between straw and ash application nor any interaction of these treatments with N-application during the first four seasons. However, over time straw, split N-application and cropping system effects interacted significantly indicating that cropping system effects on N-use efficiency needed time to built up.

Keywords: Cropping systems, field survey, rice diseases, Southeast Asia

Effects of Manure Quality and Application Forms on Soil C and N Turnover in a Subtropical Mountain Oasis — A Laboratory Simulation of Agricultural Practices

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Our knowledge of the agricultural sustainability of the millennia old mountain oasis in northern Oman is restricted in particular with respect to C and N turnover. For this reason, a laboratory study was conducted to analyse the effects of rewetting and drying on microbial biomass and activity after adding organic fertilisers, to investigate the effects of a local practice where organic fertilisers are initially mulched and later incorporated into the soil, and to evaluate the relationships between C and N mineralisation rates and quality indices for different age types of manure. During the first 9 d “mulch” period, the content of extractable organic C decreased by approximately 40 % in all 4 treatments. During the second 9 d “incorporation” period, this fraction decreased insignificantly in the NIL and old manure treatment and by a further 10 % in the young manure and faeces treatment. The NIL and the old manure treatment form the first pair with a low percentage (0.3 % in 18 d) of organic C evolved as CO₂ and a considerable percentage of total N mineralised as NH₄ and NO₃ (1 % in 18 d), the young manure and faeces treatment form the second pair with a high amount (0.5 % in 18 d) of organic C evolved as CO₂ and no net N mineralisation. During the first 9 d period, the microbial biomass C content increased by approximately 150 % in all 4 treatments. During the second 9 d period after incorporation of the organic fertilisers, no further increase was observed in the NIL and young manure treatments and a roughly 30 % increase in the other two treatments.

Keywords: CO₂ evolution, drying and rewetting, microbial biomass, N-mineralisation, substrate quality

Microbial Performance in Soils of a Sub-Tropical Mountain Oasis in Oman Abandoned for Different Time Periods

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Little is known about the agricultural sustainability of the millenia old mountain oases in northern Oman. To elucidate the coherence between the length of a fallow period and microbial performance, samples of 11 terrace soils abandoned for different time periods were collected *in situ*. These samples were transferred to Germany, rewetted and incubated for 30 days in the laboratory. The best coherence between estimated fallow age and soil microbial properties was revealed by the microbial biomass C-to-soil organic C ratio, which declined with decreasing availability of substrate to the microorganisms. Similar close relationships to the estimated fallow age could be drawn from the microbial biomass N-to-total N ratio and the contents of microbial biomass C and biomass N. Poor indicators of fallow age were all soil organic matter related properties, such as the soil organic C content or the soil C-to-N ratio. During the 30 day incubation following rewetting, relative changes in microbial activity (respiration, N mineralisation, N fixation) and biomass (C and N) indices were similar for the 11 terrace soils. The decline of a certain microbial community was reflected by increasing concentrations of extractable organic C and organic N in combination with a decreasing concentration of inorganic N. Growth was indicated by the opposite behaviour of all three fractions. This study was part of a larger project focusing on the sustainability of oasis systems, especially with respect to the question of how the current levels of agricultural inputs affect C and nutrient balance under regular irrigation and high ambient temperatures.

Keywords: Arid climate, CO₂ evolution, fallow, microbial biomass, N-mineralisation, rewetting

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Public Health and Social Implications of Water-Related Innovations

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Water and Health: Both words stand for extremely complex and inter-related systems. The interrelationship between freshwater ecosystems and human ecosystems, and the problem of safeguarding the health of the two systems will be discussed.

Public Health describes health as a public good and human right, and in the context of this paper ecological, political, technical, managerial social and cultural determinants in relation to water and health of the community at large.

Water-related Innovations refer to domestic water supply, water for agriculture, animal husbandry and food production, but also to disease prevention and control, sanitation, urbanisation, mining, industrialisation and energy production but also to disaster prevention and management — and their effects on health.

Users of freshwater resources, once they are scarce, are competing both at local as well as higher economic and political levels. Increases in population and population density mean an increasing demand on water and more waste water and ecosystem pollution. Innovations with respect to water supply, with all good intentions to improve quality and/or quantity of water for human consumption, may have unexpected effects on health.

The integral role of water in the process of development and poverty reduction has been recognised over the last two decades, with several international agreements specifying targets on water supply and sanitation, dating back to the UNICEF 1980 International Water Supply and Sanitation Decade (IWSSD). Only recently in 2003, UNESCO published a joint report by 23 UN-agencies concerned with fresh water (UN-World Water Development Report, 2003), in which all aspects of “Water for People and Life” have been addressed and the role of water for poverty reduction, better health and economic growth has been acknowledged.

Keywords: Water related innovations, water consumption, water demand

Aspects of Water Resource Management and Hydrosolidarity on the Level of Farming Systems and Households in the Eastern Jordan Valley

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Growing water demand in all economic sectors of the Near Eastern countries inevitably presses for a change in the allocation of the scarce water resources in terms of quantity and quality. Agriculture, as the current principal consumer of freshwater, will not only face a reduction of water supply but also a rising share of low quality water, which originates from the increased freshwater consumption in other sectors. Meeting this challenge demands a management of water resources that considers simultaneously social imperatives, environmental sustainability and changes in the sources of living standard for farm/household systems and the livelihood of rural communities. Hydrosolidarity, as a conclusive term for ethic principles in water distribution, has only room for manoeuvre if a balanced development for all actors and stakeholders in the concerned regions can be attained. The Jordan Valley is the smallest of the four large-scale watersheds in the Near East and allows thus for relatively clear and representative analyses of quantitative relationships between water users and their dependencies on water resources. On the Jordanian side, adjacent urban areas, in particular the capital Amman, compete to an increasing degree for surface water from rivers and dammed temporary creeks, which provide the principal source of water for irrigation. Treated wastewater from the urban areas adds an increasing component to the overall water balance of the Valley, but remains an ambivalent issue due to suspected negative impacts on soils, groundwater and the quality of agricultural products. The analysis of 137 representatively selected farming systems and agricultural enterprises in the middle and northern part of the Valley allowed for a first estimation of the potential impacts from changing water quantities and qualities on the economic success and living standard of the different types of concerned households. The results show that pursuing the goal of hydrosolidarity, which considers the rights of the weaker members of the population as well as measures against the increasing damage to natural resources and habitats, demands for a management that goes beyond the boundaries of the watershed and combines the development in agriculture with the growth in the other economic sectors.

Keywords: Farming systems, hydrosolidarity, Jordan Valley, water resource management

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Decision Support Based on Bio-Economic Simulations for Irrigated Agriculture

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Irrigation has been fundamental to guarantee the supply of agricultural products. Its importance increases with world demographic growth. The benefits of irrigation are: larger economic returns to agricultural activities due to higher productivity, expansion of the agricultural frontier, improvement of economic conditions for rural communities, and others. The establishment of drainage systems in wet areas brings similar benefits as irrigation. In dry areas, where irrigation is practised, drainage is an effective measure to control salinity, a problem faced by the majority of irrigated areas. The need for the integration of irrigation and drainage in the design and management of projects is evident. An appropriate soil-water-plant-salinity management is important to guarantee sustainable agricultural production at high levels. Unfortunately, appropriate management is often lacking. Computer simulation models can be effective decision support tools for the design and management of irrigation projects, apart from contributing to agrotechnology transfer. However, few models of this kind are applicable in developing countries. One of the causes is the lack of a sufficient database.

This paper introduces a computational model for decision support for irrigated agriculture. Its flexible input data base turns it appropriate also for developing countries. The model is applicable to different scales ranging from production units to irrigation perimeters.

Components of water balance in root zones are calculated on a daily basis. Crop yields are predicted, considering stresses due to root zone water deficit or excess, and soil-water salinity. Based on these estimates and additional major economic parameters, financial and economic analyses are carried out. Optimization procedures are applied for different production scenarios, considering water, labor, area and market constraints.

The model, which is currently in its testing phase, has been applied to projects in different regions in Brazil. Its potential as a decision support tool for irrigated agriculture and technology diffusion in other situations is now verified.

Keywords: Computer simulation model, crop yield, economical analyses, soil-water-plant-salinity management

Salinity in Irrigated Rice — Differentiation between Environmental and Salinity Effects on Yield Gaps

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In many semi-arid environments, irrigated rice is grown along the major river systems as the only staple crop that is not rain fed. Semi-arid environments are characterized by a strong seasonality, normally a distinct rainy season and an off-season with little rainfall and extreme temperature amplitudes. Any crop grown in those environments needs to be adapted to the climatic conditions and often climate alone is responsible for large gaps between potential and actual yield. Salinity effects are known to be influenced by climate. Dry conditions and high vapor pressure deficits increase the stress for the crop, whereas humid condition mitigate stress effects. It has often been observed, that salinity induced yield gaps differ among the two major seasons. The aim of this study is to identify yield component traits, that are just affected by the climatic conditions, just by salinity or by a combination of both. Ultimately, knowing which of the parameters contributing to a salinity induced yield gap is affected by climatic conditions and which is not, leads to the selection of better adapted rice varieties to both moderately saline and sub-optimal climatic conditions. Yield and yield components of 54 rice varieties were studied under fresh-water and saline water irrigation for six seasons in the semi-arid conditions of Sahelian Senegal. Potential yield was calculated by season for both treatments on the basis of a 100 percent performance of all yield components. Climatic effects on yield were calculated from changes in yield gap composition from one season to the next, salinity effects were determined from changes in the yield gap composition between the treatment within one season. The results are discussed with regard to selection and breeding strategies.

Keywords: Breeding, climate effects, salt stress, selection tools, yield components

Is the Transpiration History of Rice Leaves Indicative for the Salt Load of Individual Leaves?

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The question raised in the title was already once answered negatively by an English group working on rice seedlings using a tracer for water use. However, that study concentrated on leaf blades only. Our earlier work has shown, that leaf sheaths and leaf blades of field grown irrigated rice subjected to salinity differ in sodium accumulation. After the appearance of the leaf, the leaf sheaths accumulate sodium, whereas the little sodium is found in the leaf blades. With the leaf fully expanded, leaf sheath accumulation of sodium slows down, whereas leaf blade accumulation of sodium increases. Through sequential transpiration measurements on the same leaf, we are now able to accurately estimate the water use of individual leaves through their life cycle and through sequential sampling throughout the life cycle of the plant, we know the accumulation of sodium in the leaf sheaths and blades of any particular leaf.

Based on the overall water-use of the plant and the share of the leaf area of any individual leaf of the total leaf area, combined with the results on stomatal conductivity from the sequential transpiration measurements, we know how much water passed through any leaf sheath and blade of the particular rice plant. Since water is the carrier for sodium in transpiration-driven xylem transport, the amount of sodium passing through those tissues can also be known. In our study we compare two rice varieties differing in salinity resistance. Individual leaf water-use and salt uptake will be calculated for sequential leaves. The results will be presented and discussed.

Keywords: Leaf appearance, leaf sheath retention, sodium uptake, stomatal conductance, water-use

Water Use Efficiency and Maize Productivity in Ouémé Supérieur, Benin

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The imbalance between soil nutrient input and nutrient output, the degradation of soil by erosion and decline of soil organic matter, the increasing invasion of agricultural fields by weeds such as *Striga* and *Imperata* spp. and the very low crop productivity are the observed results of low soil fertility. Due to the low crop productivity and high evapotranspiration caused by the above factors, water use efficiency of the crop is also affected. Practical methods to reduce evaporation from soils and to conserve water could be the use of organic matter and mineral fertilizer. The aim of this work conducted in Ouémé supérieur in the northern part of Republic of Benin is to study the effect of organic matter and mineral fertilizer on water use efficiency of maize.

Field experiment was established in 2002 on three sites (Doguè, Wèwè and Bétérou), using a complete random block with four treatments and eleven replicates distributed in these sites. Treatments were: farmer's practice (T_0); 10 T ha⁻¹ of mulch (T_1); 75 kg ha⁻¹ N, 40 kg ha⁻¹ P₂O₅, 24 kg ha⁻¹ K₂O (T_2) and 10 T ha⁻¹ of mulch with 75 kg ha⁻¹ N, 40 kg ha⁻¹ P₂O₅, 24 kg ha⁻¹ K₂O (T_3).

Water use efficiency was determined by the ratio between the yield or above ground biomass and the actual evapotranspiration (ETA). ETA was estimated using gravimetric humidimetry and tensiometry methods, and was partially measured by the aerodynamic method. Higher yield and WUE (grain, cob and straw) were obtained with T_2 and T_3 . Statistical analysis showed a significance difference between treatments for grain and its WUE (T_0 and T_3), for straw and its WUE (T_0 and T_2 ; T_0 and T_3), proving that water use efficiency is highly affected by mineral fertilizer and the combination of mineral fertilizer and mulch.

Keywords: Evapotranspiration, gravimetric humidimetry, tensiometry, water use efficiency, Benin

Effects of Salinity on Tiller and Leaf Number, Leaf Appearance Rate, and Leaf Duration in Rice

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Salinity effects on leaves observed in field trials, are generally reported by identifying the youngest fully developed leaf and relating to any other leaf starting from here. In Studies under controlled conditions leaf positions are identified and numbered by appearance. However, those studies generally concentrate on young seedlings without additional tillers. Hence, in field trials including sequential samplings of different leaf levels, the identification of the leaf position according to the developmental sequence is virtually impossible. The issue is further complicated when control plants are to be compared with stressed plants. The leaf appearance rate of rice plants subjected to salt stress is likely to differ from non stressed plants, as is the duration of physiological activity of individual leaf positions. We studied appearance rate and life cycle of individual tillers and leaves in two irrigated rice varieties differing in salinity resistance grown in hydroponic culture in a greenhouse. Treatments comprised two salinity (0 and 60 mmol NaCl) and in combination three potassium treatments (20, 40 and 80 ppm). Tiller number and leaf number was reduced in all salinity treatments for both varieties. Higher potassium concentration in the culture solution resulted in larger leaf area and higher tiller number in the control treatments as compared to lower potassium concentrations. Salinity increased senescence rate of individual leaves and shortened significantly the physiologically active period. We developed a rating system for leaf senescence to accurately describe the development stage of any individual leaf independent of the treatment. Results on the effects of salinity on leaf appearance rate and leaf duration will be discussed.

Keywords: Leaf development, leaf senescence, potassium nutrition, salt stress, tillering patterns

Concept Models to Simulate Salinity Effects on Leaf Appearance, Duration and Transpiration in Rice

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Rice varieties subjected to salinity have different strategies to cope with the stress. The most prominent strategies are avoidance or tolerance of critical salt levels in active tissues. More often, however, a combination of avoidance and tolerance traits is observed, due to the high agronomic performance desired of the cultivars in question. In this respect, the most critical question for the selection of salinity resistant rice varieties is, apart from agronomical considerations, how does the plant cope with the salt that it could not avoid taking up? Here two considerations are important: (1) what is the individual salt-threshold of any tissue? And (2) what are the dilution factors for any tissue the plant can achieve through growth of the particular organ. Assuming, that the resulting concentration of sodium in any tissue is directly related to the amount of water that passed through the tissue and knowing, that the root is no sink for sodium but the leaf sheaths are, we developed a model simulating water and sodium uptake into a growing rice plant. Concepts for the effects of salinity on growth and appearance rate of individual leaves were developed from our ongoing work on salinity in rice. Contributions of individual leaves to the overall water-use of a rice plant were simulated for saline and non-saline conditions on the basis of individual leaf area, transpiration and duration of the leaf. Preliminary results show, that the salt-resistant variety used less water during the trial than the salt susceptible one, on both total leaf area basis and on individual leaf area basis. The concepts and results will be discussed.

Keywords: Modelling, potassium nutrition, salt distribution, salt uptake, sodium retention

Saving Water with Ground Cover Rice Production Systems at the Price of Increased Greenhouse Gas Emission?

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Submerged lowland rice fields make a substantial contribution to global warming by emission of greenhouse gases, typically methane, CH₄. The impact of paddy rice production on nitrous oxide (N₂O) production is less clear. The strong anaerobic conditions of the bulk soil of paddy rice fields promote CH₄ production, while they might limit N₂O emission. Water-saving rice production systems have not been tested so far. Here we present an evaluation of the water-saving GCRPS for its impact on emission of methane and nitrous oxide.

Two Ground Cover Rice Production Systems using thin plastic film or straw mulch soil cover were compared to traditional paddy rice production in three major Chinese rice regions, Beijing, Nanjing and Guangzhou. There was a pronounced effect of water management. In the traditionally submerged rice fields, methane emission was dominant, and only during the drainage period before panicle initiation nitrous oxide emission were found. In contrast, methane emission from GCRPS was negligible in Beijing and Nanjing. Only in Guangzhou after heavy rainfall in the beginning of the growing period, both systems showed similar methane fluxes. N₂O emission generally increased with water-saving GCRPS, and emission events were clearly linked to fertilization. Considering the global warming potentials of CH₄ and N₂O, the compensation of reduced CH₄ emission by increased N₂O fluxes became evident. Our results show that, for Beijing and Nanjing, GCRPS led to a small increase in the total effect of GCRPS on global warming, while in tropical Guangzhou with high CH₄ emission from traditional rice system, GCRPS resulted in a small reduction.

Keywords: GCRPS, green house gases, global warming, rice production system, China

Indigenous Knowledge and Practices for Soil and Water Management in East Wollega, Ethiopia

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The study was conducted in western Ethiopia in order to identify local soil and water management related knowledge and practices of the farmers in order to utilize the output in further research and development interventions in the area. The awareness about the existence and extent of land degradation and nutrient depletion; and its contributory factors are pre-requisite for farmers to undertake any effort to arrest the problem. Farmers in the study area recognized soil erosion and nutrient depletion, and established cause and effect relationship between factors. The major causes of land degradation and nutrient depletion are soil erosion, intensive Tillage, exhaustion of nutrients by crops and deforestation. Apparently, crop type and crop management were emphasized particularly with respect to soil erosion. Small cereals like tef (*Eragrostis tef*), which require highly intensive tillage and smooth seedbed are considered detrimental while legumes and oil crops contribute positively to the land quality. On the side of the solution to these over-riding problems, they have various options ranging from simple mechanical or agronomic to integrated; and from a field level to a watershed scale. Some of the indigenous soil and water management practices identified in the area are consistent with similar practices found in different parts of the country, while some are unique to the area. Joro for soil conservation and nutrient management, and ciicata, Kolaasaa and their integration with crop rotation for soil fertility maintenance and weed control are among the unique practices to the area. The practices are widely used in the study areas, and are appreciated by all the farmers. Detail description and rationale of every practice is discussed in this paper.

Keywords: Local practices, soil erosion, nutrient depletion, Ethiopia

Results from a Spatial Water Allocation and Choices of Technologies Model for Irrigation Systems — A Case Study on Watershed Management in Shaanxi, China

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The issue of efficient water use has attracted much attention. For instance, China is facing severe water shortage due to geographical and demographic arguments. Especially under-developed water conservation technology and inefficient management are big problems for farmers and the government. Major questions at hand are how to improve water use efficiency, to optimize water allocation in agriculture, to invest in water saving technologies, and to assure water for high value added agriculture.

This paper investigates the impact on water use efficiency by taking into account individual farmers' adoption of modern water saving technologies and improvements of water transit, contributed by the public sector, from sources to end of canals. It shows results from a spatial water allocation model (SWAM) according to the approach of Umetsu. The main contribution of the study is to optimize the water allocation and choices of irrigation technology for farmers in a Chinese water project. Empirical data for the study was collected from a northwest Chinese county, Li Quan, Shaanxi Province in 2000, in which the farming system is dominated by apple production. Farmers ensure their food security by growing apples for food exchange. The SWAM model uses GAMS for optimization. The model contains an objective function of net benefits of a watershed subjects to several constraints. The most important constraints are equations of motion for canal water and groundwater which it takes into consideration simultaneously. The other constraints are farm water use efficiency as a function of private investment and canal water loss rate as a function of public investment in water transit, respectively. The SWAM model is a dynamic programming model, which is characterized by a variation of water use over the project area. By solving the SWAM model the net benefit in the watershed, the canal water consumption, the groundwater consumption, the investment in public canals, and the suitable technologies for farmers, as applied in different locations, are optimized. The model results are of great value for policy maker and project manager to allocate water efficiently, optimize irrigation projects, and provide references for farmers to apply suitable water conservation technologies.

Keywords: A spatial model, water use efficiency, water allocation, irrigation technology

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Effect of Drought on Gas Exchange and Carbohydrate Metabolism in Pearl Millet

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Two weeks old pearl millet plants (*Pennisetum glaucum* L.) were exposed for two weeks to severe drought in a climate chamber. A drought sensitive (841B) and a drought tolerant (Sadore) pearl millet genotype were exposed to the stress. Drought was induced by withholding water until the soil reached an pF value of 4.8, which was then maintained by watering the pots to a certain weight twice a day. The relative humidity was 40/60 % (day/night) and the light period was 12 h. After two weeks of drought treatment, the plants were harvested after 6 and 12 h of the light period and at the end of the night. In some of the plants which were harvested at the end of the night, several of the source leaves were removed at the beginning of the dark period. At harvest, the third leaf from the apex (leaf 3), the first leaf from the apex (leaf 1, still enclosed in the second leaf) and the fine roots were immediately frozen in liquid nitrogen.

The water potential of leaf 3 was more reduced in the sensitive genotype than in the tolerant genotype in response to drought. The net photosynthetic rate was strongly diminished by the drought treatment. Although drought decreased the stomatal conductance by more than 90 %, the decrease of the net photosynthetic rate was mainly caused by a reduction of the mesophyll conductance to CO₂.

Under drought the starch degradation during the night was hampered. This is an indication for a disturbed starch metabolism of the leaf and/or a strongly reduced sink activity under drought. The artificial alteration of the sink/source ratio allows indications about the role of the sink/source relation on the carbohydrate metabolism in response to drought.

Keywords: Carbohydrate metabolism, drought, gas exchange, pearl millet

Regional Water Use of Natural Plants in the Draa Valley — Southern Morocco

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Compared to the basic information of the water use of oases in arid regions, just a few is known about the areal water use of the natural plants, even if they form the vegetation cover of major parts of the region. In addition, there is also just a little information about the biomass distribution of natural plants. Investigations of ecophysiology and spatial distribution of different natural plants were carried out in the Draa valley, southern Morocco, in the years 2001–2003, in order to achieve an estimate of the plant influence on the hydrological circle of this water catchment.

Ecophysiological measurements were placed in two characteristic rangeland areas of the Draa valley, the southern site at El Miyit (792 m a.s.l.), located within a large basin at the foot of the Jebel Bani and characterised by large areas and small Wadis were most of the vegetation concentrates. The dominant plant species are *Acacia raddiana*, *Retama reatam*, *Withania adpressa* and *Ziziphus lotus*. The northern site, Taoujgalt (1,900 m a.s.l.), is located at the southern slope of the high Atlas mountains with a homogeneous plant cover. The dominant perennial species are *Artemisia herba-alba* and *Teucrium mideltense*.

The results show that in both areas the annual water use of the natural plants is less than the annual precipitation, but the primary processing time of water use of the north area is the second half of the year. This is different from the southern area, where main water use occurred in spring. The reason for this is found to be the biomass constitution. The dominant species *Artemisia herba-alba* representing two third of total biomass at Taoujgalt, with a maximum in autumn both for biomass as for leaf area based transpiration rates. Contrary to El Miyit were the plant transpiration is strongly depended on the local rainfall, areal transpiration rates of the northern area are less closely linked to local precipitation, and may even exceed precipitation in some months. This indicates the influence of local water storage in the soil, and/or the influence of groundwater fluxes within this mountainous region.

Keywords: Biomass, desert, hydrological circle, precipitation, South Morocco, transpiration rates, water use

Estimation of Seasonal Actual Evapotranspiration through Optical Satellite Imagery

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Evapotranspiration (ET) is an important component of water balance, but its quantification at large spatial scales is not a simple task. Since the last two decades, many retrieval algorithms using optical satellite imageries were developed to estimate spatially distributed actual ET at regional scale, which is shown to be effective in agricultural areas with irrigated upland crops. To date, it is not known whether these algorithms also work well for areas under irrigated lowland rice in the tropics. Lowland rice is grown under continuously flooded conditions, which may affect the accuracy of retrieval algorithms.

In this study, the Surface Energy Balance Algorithm for Land (SEBAL) was used to estimate seasonal actual ET from irrigated lowland rice in District 1 of the Upper Pampanga River Integrated Irrigation System (UPRIIS) in Central Luzon, Philippines. Two ASTER images and seven MODIS images from the wet season of 2000 were used to compare the seasonal actual ET at five different scales within an irrigation system. The required ground truth for implementation of the SEBAL algorithm was obtained at each satellite overpass. To evaluate the estimated seasonal ET, data from weather stations in the area were collected and used to quantify seasonal ET. A close relationship between the seasonal actual ET values derived from remote sensing data using SEBAL and the values calculated from the weather stations were observed. It is concluded that seasonal actual ET rates can be accurately estimated by integrating ASTER and MODIS images at different spatial scales from lowland rice in the tropics.

Keywords: Actual evapotranspiration, ASTER, MODIS, Philippines, remote sensing, UPRRIS

Quantification of Xylem Sapflow Measurements on Lychee Trees

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Irrigation has been established to produce crops independent of rainfall. Simultaneously it secures and increases the yields of many fruits and crops, creating cash income in many rural areas. Focusing the northern highlands of Thailand, irrigation of fruits is performed in the dry season (November–May), which is the yield-forming phase. The steady increase in lychee production raises also the potential for conflicts about water.

In order to investigate efficiency of irrigation, a farmer's lychee has been equipped with highly sensitive instrumentation. One of these instruments is the sapflow-sensor which enables to measure sapflow-density. It consists of a thermocouple, which is implanted to the tree's xylem tissue. The system uses a method of heat balance equation to conclude on sapflow-density in the xylem. An approximation of actual transpiration of the tree can be estimated, using a representative cross-section of the tree trunk. This equation deals with the assumed area of water-transport pores within a given diameter of a tree. Investigations on the actual specific pore area (SPA) within the xylem tissue were carried out in order to correlate the measured values to an actual transpiration value [$L/d*\text{tree}$]. Knowing the relative value of sapflow density and SPA it is possible to conclude on transpiration rates of the tree. Transpiration is the consumption of water by the tree, described by the k_{cb} -value, which — in combination with the k_e -value for the evaporation — allows to calculate the potential evapotranspiration in a lychee-orchard based in the reference-evapotranspiration according to the Penman-Monteith equation.

Furthermore, interactions between soil water suction and transpiration of lychee trees, which are important to monitor water stress, are being investigated for two years. Therefore the trees, which had been exposed to different levels of water supply, were monitored on soil water balance at the means of tensiometers and TDR-probes. Xylem sap-flow of the trees has been continuously monitored. Stomatal conductance and leaf water potential during the course of a day were determined by a porometer and a Scholander bomb respectively. The obtained data allowed a relative description of the trees reaction to water supply.

Keywords: Evapotranspiration, crop coefficient, lychee, sapflow, stomatal conductance

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Breeding for Drought Tolerance in Sesame (*Sesamum indicum*)

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Drought is a major environmental abiotic stress that limits Sesame production in both marginal and adequate rainfall areas with long dry spell during the growing season. Improvement of cultivars for drought resistance is one of the major objectives of sesame breeding programs in the Sudan. Three phases of field investigations were carried out in collaboration with University of Khartoum to assess the extent of variability, study the inheritance and breed for drought tolerance in this crop.

Seventeen sesame genotypes of diverse origin were field tested under water stress and well-watered conditions across two locations in year 2000. A wide range of genetic variation was detected for the studied characters as well as among the genotypes. Genotype \times environment interaction was significant for seed yield/plant and most of its components. Superior genotypes maintained highest yield/plant over two locations but in a different rank. Drought tolerance was assessed as the ratio of yield under water stress (Y_s) to the yield under normal irrigation (Y_i). (Y_s/Y_i) was moderately heritable, exhibited a weak correlation to seed yield and yield related traits, and indicated that seed yield and its attributes were sensitive to water shortage more than the morphological characters. (Y_s) was negatively correlated to drought tolerance (-0.54), it had heritability of (0.72) which suggests good prospective for improvement of this trait.

Based on crop performance in response to water treatments, four genotypes (three most drought tolerant and one most susceptible) were selected and used as parents in a crossing program. Mating designs of backcross, diallel, triallel (3-way cross) and quadriallel (double-cross) were used.

Components of genetic variation were investigated employing partial diallel fashion. Involvement of both additive and dominance gene actions was found to be important in inheritance of the studied characters. Variance components of epistatic nature and order of parents' involvement in crosses were estimated.

Keywords: Drought tolerance, mating design, sesame, *Sesamum indicum*, Sudan, water stress

Saving Water with the Ground Cover Rice Production System in China

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In China, the water demand for agriculture accounts for about 71 % of the total water consumption, and 70 % of all water used in agriculture is consumed in paddy rice production. In the last decade, increasing agricultural production and industrial growth led to a severe shortage of water resources, and in northern China, the problem has reached a dramatic extent. The water use efficiency of paddy rice is low, and the demand for irrigation water is at least twice as high as in other cereals, while the physiologic demand of the rice plant for transpiration accounts for only 10–12 % of total water used in paddy rice production. The aim of the present study was to evaluate and improve this new water-saving technology of rice cultivation for competitive yield and increased water use efficiency.

With the new technique, the so-called ground cover rice production system (GCRPS), the soil is irrigated to approximately 70–90 % water holding capacity, and covered by plastic film (0.0014 mm), or plant mulch. In 2001 and 2002, identical field experiments were carried out in three Chinese locations (Beijing, Nanjing and Guangzhou) representing three major rice growing regions in China. Our results show that, GCRPS reduced the water demand by up to 60 %, depending on soil conditions. This reduction cannot be explained by reduced evaporation only. Seemingly in paddy fields, seepage was much higher than usually assumed. Rice grain yields were typically up to 10 % lower than in paddy rice, grown as a control, only in Beijing, micro-element deficiency and difficulties in nitrogen fertiliser management contributed to higher yield penalty in GCRPS. Unexpectedly, fertiliser nitrogen use efficiency (NUE) was high in traditionally submerged control fields and fell back in GCRPS. Only with expert system fertilizer management (based on SPAD), improvements were achieved.

Keywords: GCRPS, water saving technology, water use efficiency, China

Evaporation under Lychee Trees — Determination of Evaporation Coefficients

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In the north-western part of Thailand, lychee production became an important income source for highland farmers. However, water scarcity during dry season bears conflict potentials between highland and lowland farmers. One solution to encounter this problem is the introduction of site adapted and more efficient irrigation performances. A simple method of irrigation scheduling for different crops displays the FAO-24 crop coefficient (K_c -value) approach. Thereby the potential evapotranspiration of a crop can be computed by multiplying a crop specific K_c -value with a potential reference evapotranspiration (ET_0). Since especially in irrigated agriculture water demand is underpredicted, the FAO-56 dual crop coefficient approach was introduced. The K_c -value is thereby calculated by the sum of a transpiration (K_{cb}) and an evaporation coefficient (K_e).

Within the framework of the Uplands Program “Research for Sustainable Land Use and Rural Development in Mountainous Regions of Southeast Asia”, K_{cb} -values of lychee trees were already successfully determined by means of sapflow measurements. The objective of this study is to investigate the evaporation under lychee trees in order to determine precise K_e -values. Therefore, the potential evaporation under the vegetation-free trees will be measured with self made evaporimeters on strategically positions. Replicates on slope and plateau accounts for the variability, both, between trees and induced by topography. The measured potential evaporation serves as boundary condition for the subsequent determination of the actual evaporation by means of soil water balance modelling. Soil water characteristics for modelling have been defined by soil water balance investigations. The K_e -value can be finally computed using ET_0 data (provided by a weather station in the lychee orchard) and the modelled actual evaporation.

Keywords: Evaporation, lychee, K_e -values, Thailand

Water Supply Situation in Benin, West-Africa

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The presently sufficient average quantity of 4.220 m³ of sweet water per person and year in Benin indicates that the unsatisfactory access to save drinking water must be caused by other factors than climatic and hydrologic conditions. On the other hand water demand has increased due to the growing population and higher standards of living, leading to more competition and conflicts between the consumers. The survey of water consumption, socio-economic and socio-demographic data as well as the amount of water supply facilities and management problems stand in the centre of these investigations.

The results indicate that Benin has regional and temporal differing water stress situations, which are mainly caused by missing technical and financial means as well as hydro-geological conditions. Additionally the inaccurately defined administrative structures and competencies obstruct the organisation and efficiency of the water supply in Benin.

Although the results of the local investigations show times for water fetching of six hours per day and household in the dry season, the water scarcity is for nearly 95 % of the interviewed persons not a reason for migration. Family relations and possession of farming land have a higher value in this aspect. It is shown however that the enormously time-consuming water fetching needs one complete worker alone for the water supply in the dry season, so that the economic efficiency of each household is immensely weakened. The readiness to pay for a better water supply is particularly given in the dry season. In the rainy season the people often use natural water sources such as “marigots”, which have a doubtful water quality. The mainly used water supply facility is the well. Its acceptance is far higher than this of a pump. Even households with a private tap and a save water supply all year have a high affinity to use water out of wells. Personal preferences, social contacts and the taste of water are still a very important factors for the selection of the used water source. This should be taken into account for the national water supply strategy and for the work of NGOs.

Keywords: Benin, water availability, water consumption, water demand

Generation of a Uniform Dripping for a Micro-Irrigation Emitter

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Worldwide water is becoming an increasingly scarce resource, imposing the need on irrigated agriculture to optimize water use efficiency. Micro-irrigation is the most water-saving irrigation technique, as water is applied locally. Among the several micro-irrigation techniques especially sub-surface drip-irrigation has a high water-saving potential, as water is directly applied to the root-zone, thus virtually no evaporative losses occur.

Uniformity of irrigation-water distribution is a key-issue in designing water-saving micro-irrigation schemes, as a non-uniform application causes leaching losses. As micro-irrigation systems operate at a low-pressure (around 1.0 bar) in undulating areas even small level differences may cause important distortions of uniformity. Therefore, a variety of methods for pressure compensation have been developed, generally on the base of a plastic membrane in a two-chamber emitter unit, which increases or decreases the flow-diameter according to incoming pressure. However, due to inhomogeneous production, the uniformity seldomly lays above 95 % and for cheap products even below 70 %, which is unacceptable according to both ASAE standards and ISO-norm.

At Hohenheim University an interrupting emitter is being tested, which can be operated independent of the incoming pressure. A weight switch regulates the filling height of a reserve chamber from where the water drips out with a constant discharge rate. In order to guarantee a constant outflow the shape and the width of the orifice has to be adequate. The common equation to calculate the outflow of a container approximates reality by coefficients for material and typical outlet shapes. The dripping is not well described by this formula. Therefore a variety of different orifices for such drip outlet openings have been tested on their constant outflow and corresponding coefficients for the shape of the openings have been determined. For the application in the dripper that openings were identified, for which least outflow variation on changing water levels occurs.

Keywords: Dripper, gravity, outflow, pressure-compensation

Field Measurements of the CO₂ Evolution Rate under Different Crops During an Irrigation Cycle in the Mountain Oasis Balad Seet, Oman

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Our knowledge of the agricultural sustainability of the millennia old mountain oasis in northern Oman is restricted in particular with respect to C and N turnover. For millenia oasis agriculture has been the backbone of rural livelihood in the desertic Sultanate of Oman. However, little is known about the functioning of these oasis systems, in particular with respect to the C turnover. The objective was to determine the effects of crop, i.e. alfalfa, wheat and bare fallow on the CO₂ evolution rate during an irrigation cycle in relation to changes in soil water content and soil temperature. The gravimetric soil water content decreased from initially 24 % to approximately 16 % within seven days after irrigation. The mean CO₂ evolution rates increased significantly in the order fallow (27.4 mg C/m² · h) < wheat (45.5 mg C/m² · h) < alfalfa (97.5 mg C/m² · h). It can be calculated from these data that the alfalfa root system contributed nearly 4 times the amount of CO₂-C than the wheat root system. The decline in CO₂ evolution rate, especially during the first four days after irrigation, was significantly related to the decline in the gravimetric water content, with $r = 0.70$. CO₂ evolution rate and soil temperature at 5 cm depth were negatively correlated ($r = -0.56$, $n = 261$) due to increasing soil temperature with decreasing gravimetric water content. This study was part of a larger project focusing on the sustainability of oasis systems, especially with respect to the question of how the current levels of agricultural inputs affect C and nutrient balance under regular irrigation and high ambient temperatures.

Keywords: Arid climate, soil respiration, sustainability

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Challenges for Herders in Mongolia

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Pastoral livestock production is a major sector of Mongolia's economy. Livestock became the only livelihood basis for rural households when the economic transition started in the early 1990s. At that time, many people took up herding as the only way out of poverty. Today, livestock provides the direct basis of livelihood for about one third of Mongolia's population.

Livestock numbers increased since the early 1990s reaching about 30.2 million head by the year 2000. Subsequently, three consecutive extremely harsh winter conditions (dzud), preceded by uncommon droughts, occurred during 2000 to 2003 and killed about 11 million head livestock, with small herders being hit most. The large outbreak of foot and mouth disease has further eroded the economic basis of the herding community and the country's economy.

Living in a very harsh climate, characterized by extremely cold winters and dry summers, Mongolian herders have developed a nomadic lifestyle, as the most effective response to the ecological conditions, and to efficiently use the vast pastoral resources. Over centuries, herders have developed hardy breeds of Bactrian camel, cattle, yak, sheep, goat and horses that have adapted particularly well to the extreme climate and scarce feed resources. Livestock products are of excellent quality, of which the most famous is Cashmere. However, production levels are low and marketing of livestock products is limping.

The present paper will discuss the major characteristics of Mongolia's livestock production and its current problems. The challenge of Mongolian herders is to take advantage of the opportunities offered by the new market economy. This will involve a drastic change in the current mind-set of the herders as well as the enhancement of both business and technical skills. At the level of the herder's camp, these changes will require an integrated approach including co-managed grazing resources, breed improvement and marketing of livestock produce. Scientists are challenged to provide practical solutions to both the Government of Mongolia and international donors like IFAD in order to address the multiple problems of Mongolia's herding sector.

Keywords: Livestock services, local breeds, marketing, nomadism, resource management, transition, Mongolia

Peri-Urban and Urban Livestock Keeping in East Africa — A Coping Strategy for the Poor?

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Until recently the main focus of agricultural development initiatives has been on rural areas with the view that improved food production in rural areas can supply the expanding urban population. However, recent data reveals that a significant proportion of the world's population growth expected between 2000 and 2030 will occur in urban areas (UN Habitat 2002). Rapid urbanization has not been accompanied by equitable economic growth and has resulted in increased urban poverty. As a result of this worsening of urban poverty, many low-income households suffer from extremely limited livelihood security.

Evidence-based data show that urban poor engage in urban livestock keeping as a response to limited alternative livelihood options and food insecurity. Five city case studies were selected in Tanzania, Uganda, Kenya and Ethiopia. The cities were Dar es Saalam, Kisumu, Nairobi, Kampala and Addis Ababa. The aim of the scoping study was to understand the current situation of poor urban livestock keepers, and identify areas where future research could make a contribution to the development and promotion of this activity.

The different case studies show that especially vulnerable groups, such as female headed households, children, retired people, widows and people with limited formal education are involved in urban livestock keeping as a form of social security strategy. It also provides a source of locally produced food products for people living in the vicinity of the livestock keepers. However, there are various externalities (zoonoses, environmental contamination, and product safety) which require addressing.

A main constraint revealed by the scoping study is the limited access to information and adoption of improved technologies by poor urban livestock keepers. This is made worse by the fact that existing services are not tailored to the needs and circumstances of the poor (e.g. extension services and training courses promote species, which are less relevant for the poor). In order to overcome these constraints technological and institutional innovations are required that address specifically the urban poor.

Keywords: Institutional innovations, livelihood strategies, small-scale livestock keeping, urban poor

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Economics of Small-Scale Dairy Farming in Sri Lanka — A Case Study from Coconut Cattle Silvo Pastoral System

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Dairy farming is a small segment in the national economy of Sri Lanka. It is predominantly in the hand of small-scale farmers. Milk production in the country only meets about 20 % of the domestic demand because of increasing demand for milk and milk products. The modest profit margin in the dairy sector has been often cited as the constraining factor for its expansion. Nevertheless, systematic research to probe the real situation of the profitability in the dairy sector is not adequate. In view of this, an empirical study was carried out to assess the profitability of small-holder dairy farmers in the Coconut Triangle of the intermediate zone of Sri Lanka, which is considered as a high-potential area for milk production.

A stratified field survey of 105 small-scale dairy farms was carried out from March–July 2002 in Sri Lanka. A semi-structured questionnaire was used to collect data from dairy farms with small herd sizes (10–15 heads) typical for the region. The farms were classified into three management systems: (1) intensive, (2) semi intensive, and (3) extensive. The profitability of dairy farming was estimated through a gross margin analysis. A statistical relationship between financial profitability and the factors affecting financial profitability was also established.

Findings reveal that dairy farming is still one of the main income source of small-scale farmers in the surveyed study area. Nevertheless, the size of owned land has become a constraint to increase the herd size and henceforth intensification. In general, about 73 % of variable costs in dairy farming consist of concentrate feeds alone. But the income gained from milk production in the intensive farms justifies the outlays.

Financial profitability demonstrates that intensively managed farms are obtaining larger profits. Multiple regression analysis was applied to demonstrate this relationship. The explanatory variables such type of management, total hours spend on dairy farming, land allocation and herd size were the main variables determining the profitability of dairy farming.

Keywords: Milk production, profitability, dairy farming, gross margin analysis, management systems, multiple regression analysis

Comparative Productivity of Black Australorp and Indigenous Chickens under Free-ranging Village Conditions in Malawi

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Black Australorp (BA) exotic breed of chicken has been introduced to crossbreed with local chickens (LC) in Malawi since 1960. Localised surveys and reviews have shown that the crossbreeding program has had no impact on improving local chicken productivity. The program however, continues and farmers like the exotic breed due to “exotic is good” mentality. As an incentive to work with indigenous (local) chickens on farmer households and for farmers to see the impact for themselves, a study was conducted to compare production characteristics of BA and LC when left to free-range on village flocks. BA (n = 125) were distributed at random to farmers in the villages at 9 weeks old. On those farmers, LC (n = 124) of the same age but hatched and mothered by a local hen were used to compare growth performance. The remaining 64 BA were kept intensive and fed commercial ration. Live weights were collected on all birds every week.

At 23 weeks of age, BA fed commercial ration were 8.36 % superior in live weights and weight gains than BA and LC on free-range in the villages. On the other hand, LC on free-range were numerically superior to BA on free-range in the villages both for live weights and weight gains. The results showed possible genotype × environment interaction, meaning BA perform better than LC when properly managed, unlike the management situation in the villages. Growth curves for both breeds showed continued growing even after 23 weeks of age. Mortality was 14.4 % in BA, 11.3 % in LC on free-range in the villages by the fifth week, while mortality was 4.7 % in BA kept intensive. This showed that BA were less adaptive to village environment and needed good management.

The current study has demonstrated to farmers that BA is just preferred due to its exotic image but is not a suitable breed to use to improve LC. The study also showed potential productivity of LC and the need to promote the local breed through breeding and management. In feedback discussion, farmers appreciated the findings of the study.

Keywords: Black Australorp, free-range, local chicken, crossbreeding, Malawi

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Pre and Post-Calving Supplement with Multinutrient Blocks to Improve the Performance of Grazing Bali Cows (*Bibos banteng*)

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Seventeen multiparous pregnant Bali cows with BCS 1 to 2, approximately 90 d before the expected date of calving, were randomly allocated to one of two feeding groups. Group A cows (n=9) were grazed on natural pasture, while group B cows (n=8) grazed with the others but received 1.25 kg multi nutrient blocks, whose constitution was as follows (%): molasses (28), urea (5), coconut cake (15), fishmeal (5), rice bran (25), lime (8.5), salt (7.5), grit (5) and ultramineral (1). Nutritional parameters such as dry matter intake, digestibility and rumen environment were estimated over a 7 d period. Cows were weighed and assessed for BCS (on a five-point scale) every two weeks, commencing at 12 weeks prior to calving, within 24 h after calving up to 16 weeks after calving. Blood metabolites were measured monthly, and progesterone was measured twice weekly using RIA. Uterine involution was determined by rectal palpation at 7 d postcalving. The interval from calving to first estrus was monitored by estrus observation twice a day. Conception at first service was assessed by pregnancy diagnosis 45 to 60 d after insemination. Results showed that except EE and NFE, dry matter and all nutrients intake as well as their digestibilities were significantly increased by supplementation. Rumen pH, ammonia and VFA levels were affected by multi nutrient blocks. Cows fed multi nutrient blocks supplement had higher liveweight, BCS, liveweight changes and slightly BCS change throughout the experiment. Blood metabolites concentrations i.e. glucose, urea and total protein were affected by multi nutrient blocks supplement, mainly around parturition. Two groups had a similar pattern of pre and post-calving progesterone profile. Five and four cows of the respective groups showed increased progesterone concentrations exceeding 1.0 ng/ml for 3 to 4 days before exhibition of the first estrus. The rate of uterine involution and conception to first service were similar in the two treatment groups, but interval from calving to the exhibition of the first estrus was shorter in supplemented than unsupplemented cows.

Keywords: Body condition score, *Bibos banteng*, Indonesia

The Potential of User-Oriented Approaches in Phenotypic Selection to Promote Conservation of Indigenous Farm Animal Genetic Resources in Extensive Production Systems — A Case of Malawi Zebu

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Predominantly, indigenous livestock in both smallholder farms and ranches in Malawi are reared under extensive production systems. These systems, which contribute quite substantially to sustainable livelihoods and food security, are among other things characterised by animals housed overnight and let out to feed or scavenge during the day while breeding-stock selection is based on phenotypes. During the day, animals from several kraals mix freely hence mating is uncontrolled and breeding is multi-sired. In extensive production systems, efforts to implement a genetic evaluation programme using the currently available methods, with the application of either a sire model or an animal model becomes almost impossible although the need to conserve and develop the genotypes within their environment and by exploiting their comparative advantage cannot be overemphasised. The current practice for selection in different agro-eco-cultural zones is based on phenotypic assessment. In whatever production system, the goal for genetic improvement is to estimate breeding values based on a procedure that maximises the probability of choosing the correct animals to become parents. We argue that user-oriented approaches have the potential in developing practical strategies through participatory nucleus herds by combining expert and producer knowledge in extensive production systems. ‘User Orientation’ in this context means that stakeholders are involved in the design, establishment, and operation of the programme. With specific examples of its application on Zebu cattle of Malawi, this paper discusses the framework describing the methodological principles to developing sound breeding strategies using the user-oriented approaches while dealing with existing constraints in extensive production system.

Keywords: Extensive production systems, farm animal genetic resources, phenotypic selection, user-oriented approaches

Body Condition and Body Weight in Northern Thai Dairy Cattle

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Body condition and body weight are reliable indicators for the adaptive performance of dairy cattle to the unfavourable climatic and feeding environment of the tropics. Beyond of this body condition scoring is a valuable tool for controlling the efficiency of dairy cattle feeding. Out of a total sample of 2764 lactating dairy cows of Holstein upgrades kept on 252 private dairy farms in the Northern Thai provinces Chiang Mai, Chiangrai and Lamphun 1672 were condition scored and their condition status assorted to 10 classes according to the time span after calving up to 500 days. In addition body measurements (height, heart girth, length) of these cows were taken on the basis of which the body weight was estimated. The employed regression coefficients were derived from a direct weight control of 234 randomly selected cows.

In general the body condition turned out to be fairly good averaging at 3.32 scores with a not too extreme variation of SD 0.77 (CV = 23 %). Contrary to the changes in body condition in high yielding Holstein cows in Thai dairy cows body condition is gradually increasing after parturition from 3.06 scores straight after calving to 3.43 scores at about 305 days in lactation and remaining about constant from that period on. This obviously has to be seen on the background of the low performance level in Thai dairy farming based on fibre rich feed sources.

Obviously resulting from insufficient rearing conditions the cows in Northern Thailand obtain only 90 % of the size and with an average of 415 kg only 70 % of the body weight of cows raised under temperate conditions. There are distinct differences to be observed between farms and between farming regions. Also between different sire progeny groups clear weight differences up to above 80 kg occur, leading to a pronounced heritability for body weight ($h^2 = 0.46$). Unexpectedly only a very small relation of body weight to the milk performance could be observed, however the relation to the fertility performance turned out to be more consistent in favour of the heavier cows.

Keywords: Fertility performance, heritability, Thai dairy cattle

Degradation of Borana Rangelands Causes Genetic Erosion of the Typical Boran Cattle

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The pastoralists in the Borana rangelands were once famous for producing the high quality Ethiopian Boran cattle. Among the pastoralists in East Africa they have disposed of the rangelands of the highest ecological potential. Today the pastures are degrading as indicated by disappearance of preferred species and encroachment of undesirable woody vegetation. Poorly designed pastoral development interventions have essentially contributed to the deteriorating situation.

The poster illustrates the impact of changed management and availability of resources on the maintenance of the Boran cattle in its original habitat. Web district, a traditional dry season grazing area associated with one of nine deep well clusters, is compared to Dida Hara. The latter is a former wet season grazing area, which has been opened up for permanent grazing by the construction of water ponds in the 1970s. PRA techniques, GPS and official maps were used to assess the status of natural resources and breed preferences of the pastoralists. Occurrence of breed types and body weights of adult cattle were measured during the peak dry and wet season.

The study revealed two distinct types of the Ethiopian Boran cattle, namely the traditional large-framed Qorti and the smaller Ayuna, as well as an intermediate type. According to the pastoralists Qorti originated from the plain grazing lands in the eastern part of Borana rangelands, whereas the Ayuna type stemmed from gradual introgression of genetic material from the highlands in the north of the rangelands. The proportion of the intermediate type in the herds was about four times higher in Dida Hara than in Web, whereas the Qorti was more frequent in Web. This difference shows that the Qorti is less adapted to the scarcity of high quality forage resources in Dida Hara than the Ayuna or the intermediate type.

The pastoralists feared that the Qorti was in danger of gradually disappearing due to the scarcity of high quality pasture and the increasing recurrence of droughts. Though they prefer the Qorti type they increasingly keep Ayuna and camels. The community-based conservation of the typical Ethiopian Boran cattle would require to secure adequate grazing and water resources.

Keywords: Animal genetic diversity, breed conservation, natural resource management, pastoral livestock production

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Body Composition of Cows Kept under Tropical Conditions — Carry-Over Effects of Feed Fluctuation

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Knowledge of composition of fat, protein and water in the body is indicative for the determination of effects of changes in nutrition in terms of body reserves. Deuterium oxide dilution technique has been proposed as easy, reliable and non-destructive method of determining body composition using the ratios of protein : water and mineral : water to predict fat.

Twenty *Bos indicus* (Boran) and 21 Boran × Holstein have been exposed for 4 years to calculated energy requirements for maintenance (M) (low) or M⁺ 20% (medium) and M⁺ 40% (high). In the third lactation these treatments were sub-divided into either low or high feeding level. Before deuterium application animals were weighed and a blood sample was collected from the jugular vein. Deuterium was slowly administered at 0.3 g/kg fasted body weight, directly into the jugular vein and the syringe was rinsed with refilled blood. Blood samples were taken at 5, 7, and 9 h post infusion and deuterium concentrations in plasma were analysed using isotope mass spectroscopy (3960 nm against water). The gastrointestinal tract (GIT) of the cows was assumed to amount to 0.20 of body weight (BW), and empty body weight (EBW) was described as $EBW = BW - GIT$. Body composition was estimated in the following equations :
Empty body water (kg) = $0.4717 \times BW$ (kg) + $0.1536 \times D_2O$ -space (kg) – 25.046
Empty body ash (kg) = $0.0363 \times BW$ (kg) + $0.0231 \times D_2O$ -space (kg) – 5.755
Empty body protein (kg) = $0.1624 \times BW$ (kg) + $0.0165 \times D_2O$ -space (kg) – 11.488
Empty body fat (kg) = $0.3790 \times BW$ (kg) – $0.2955 \times D_2O$ -space (kg) – 42.163

Previous feeding level and the genotype explained most of the differences between treatment groups. Boran cows showed higher levels of fat, but the difference of 20% and 40% of the previous medium and high treatment was still visible. Fat reserves from the crossbred cows were strongly influenced by milk production, however, cross-breds previously on low plane of nutrition replenished their fat deposits instead of producing more milk when receiving higher amounts of feed.

Keywords: Body composition, carry over, deuterium, undernutrition, zebu

Understanding the Genetic Diversity of Livestock — An Essential Step for the Management and Improvement of Farmers' Resources

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The last 10 years has seen an explosion of genetic studies aimed at improving the understanding of the origins and genetic characteristics of livestock genetic resources. Although the focus of most of this work has been Europe, remarkable progress has also been made in the developing world, thanks to the support of development agencies. Since 1995, ILRI has developed, in collaboration with National Agricultural Research Systems in developing countries, a dynamic program on the molecular genetic characterisation of indigenous livestock of Africa and Asia. Molecular diversity information on cattle, sheep, goat, chicken, yak and Old World Camelidae are now partly available at country, regional and/or continental levels. The results show that the origin of the present day livestock diversity is more complex than previously thought with evidences for multiple origins or domestications. Livestock also show different patterns of geographic distribution of diversity in relation to the history of the domesticated species. These finding have direct applications to the design of strategies aiming to conserve diversity to maximise future utilisation. We have now the tools to understand the diversity of the genetic make-up of a livestock breed or population with direct applications to on-farm and on-station breeding programs. Genetic characterisation may also provide a genetic signature for breed uniqueness within the context of intellectual property rights. Examples of applications of molecular diversity studies in livestock conservation and utilisation are illustrated by results obtained from the ILRI-led research. We present three studies: (i) the identification of cattle diversity hotspots and priority breeds for conservation in sub-Saharan Africa; (ii) dromedary breed identification in Kenya; and (iii) the possible application of phylogenetic studies for improvement of disease resistance in cattle and sheep populations.

Keywords: Conservation strategy, genetic characteristics, phylogenetic studies

Study on Reproductive Activity of *Equus asinus* in Relation to Environmental Factors in Central Ethiopia

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Reproductive activity in donkeys around the tropics is all year round with certain seasonal peaks to which often-different nutritional, climatic and managemental conditions are associated. The influence of these locally fluctuating seasonal conditions on ovarian activity was studied by real time ultrasonography in 7 local Jennies (*Equus asinus*) during the dry, short and long rainy seasons from December 2001 to October 2002 in central Ethiopia. Semi-quantitative analysis of the pasture condition and availability, and Body Condition Scoring (BCS) were carried out to study the nutritional status. The jennies developed 1–3, 2–4, 2–5 ovulatory and 1–2, 1, 1–4 anovulatory waves per animal during the dry, short and long rainy season respectively. The mean (\pm sd) inter ovulatory interval (IOI) for the dry season was longer and follicles grow slower than during the short and long rainy seasons ($p < 0.05$, 27.3 ± 7.26 days, 0.88 ± 0.74 mm per day; 23.8 ± 4.44 days, 1.15 ± 1.1 mm; 26.6 ± 6.48 days, 0.90 ± 0.64 mm respectively. Mean (\pm sd) BCS and forage estimates were found to be significantly lower during the dry season ($p < 0.001$; BCS = 2.7, 3.8, and 3.9, and Forage estimate = poor, satisfactory and good) for the dry, short and long rainy seasons respectively. BCS was positively correlated with higher grades of forage condition and availability ($t = 0.4$ at $p < 0.05$) and influenced seasonal distribution of follicles. The mean (\pm sem) maximum diameter of pre-ovulatory follicle was significantly larger during the short rainy season than the dry and the long rainy seasons (37.8 mm ± 2.1 , 31.0 mm ± 1.82 , 33.2 mm ± 1.22 , $p < 0.05$) respectively. The dry season is the main harvest period in the study locality and all the jennies were vastly used for pack and transport in the field, around the house and market during this time than the following wet seasons. Some of the minor relationship observed between seasonal climatic values and different size groups of follicle were not biologically definable. Jennies produced relatively larger follicles with better growth rate, had higher number of ovulatory waves and also a shorter IOI during the short rainy season which seems to be the best breeding period for the traditionally herded jennies. Results of this study indicate the existence of normal but significantly different ovarian activity among the seasons with the peaks mainly related to differences in nutrition and management. Tropical donkeys in this particular area are therefore not strictly seasonal breeders but the pattern of reproductive activity follow the influence of local environmental factors through the different season. The relative effects of individual factor need a further detailed verification.

Keywords: Environmental factors, *Equus asinus*, reproduction

The Effect of Fry Rearing Temperatures on Sex Ratios in Nile Tilapia — Interactions between Genotype and Temperature

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For a profitable Nile tilapia aquaculture the importance of monosex culture of males has since long been recognised. Masculinizing with hormones is in many cases applied to increase the percentage of males. Nevertheless, many consumers are interested in environmentally friendly production and refuse to consume fish which received foodstuffs that contain hormones or similar active substances. Since some years more details were discovered about the influence of environmental factors like temperature on the sex determination of reptiles and some fish species. The objective of the present study is to test the effect of different fry rearing temperature levels on the sex ratios of Nile tilapia (*Oreochromis niloticus*) from two different origins (Lake Manzala, Egypt and Lake Rudolph, Kenya). Temperature treatments were conducted with 18°C for 20 days or with 36°C and 38°C for 10 days starting at day 10 after fertilisation. Sex ratios were obtained when the fish reached approx. 30 g. Treatments with 18°C for 20 days did normally not result into sex ratios significantly different to controls. In contrast to this in most cases the 36°C treatment for 10 days led to a significantly higher percentage of males if compared with the corresponding controls. Lifting the temperature to 38°C did not further increase the percentages of males. Differences in the sensibility of the sex determining mechanism to temperature treatments were observed between the two examined origins. It could be shown that in Nile tilapia simple temperature treatments can repeatedly increase the percentage of males. The genetic background of the response of sex ratios to temperature treatments is promising for a genetic improvement of this trait. It has to be evaluated if and how fast selection programmes can lead to Nile tilapia strains which allow the easy, cheap and sustainable production of all male stocks by temperature treatments.

Keywords: Genotype-environment-interactions, *Oreochromis niloticus*, sex ratio, temperature

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Accumulation of ^{15}N in Yolks and Albumen of Hens Fed Diets Containing ^{15}N -CCC During Egg Development

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An experiment was conducted to evaluate the accumulation of dietary ^{15}N -CCC in yolks and albumen of hens fed diets containing ^{15}N -CCC during egg development. Twenty 280 days old Brown breed layer hens were fed a ^{15}N -CCC free balanced diet with 16.37 % crude protein and 11.48 MJ ME/kg. In completely randomised design, the hens were divided into 4 groups (A, B, C and D) and given on one of the 4 treatments: 0 mg ^{15}N -CCC /kg feed (control diet/ group A), 5 mg ^{15}N -CCC /kg feed (group B), 50 mg ^{15}N -CCC /kg feed (group C) and 100 ppm mg ^{15}N -CCC /kg feed (group D) for 11 days. During the 7 days followed, ^{15}N -CCC treatments were withdrawn and all chickens restored to feeding on the control diet. Eggs were collected daily during both periods and egg yolks and albumen were separated. The ^{15}N content was measured using a coupled Elemental Analyser-Continuous Flow II Interface-Isotope Ratio Mass Spectrometer (EA-ConFloII Interface-IRMS) and the $\delta^{15}\text{N}$ excess ($\delta^{15}\text{N}$ -ex) and atom percentage ^{15}N (At%) calculated. There was no significant ($p > 0.05$) difference in $\delta^{15}\text{N}$ -ex and At% of egg yolks and albumen of group B both during 11 days of feeding on ^{15}N -CCC containing diets and during the 7 days ^{15}N -CCC diets withdrawal. Feeding with ^{15}N -CCC affected ($p < 0.05$) $\delta^{15}\text{N}$ -ex and At% in egg yolks and albumen of group C and D from 8 and 3 days respectively after the beginning of feeding ^{15}N -CCC diets, and up to 2 and 4 days after ^{15}N -CCC diets were withdrawn, respectively. The $\delta^{15}\text{N}$ -ex and At% in egg yolks tended to be higher than in albumen during the treatment period. The ^{15}N concentrations reduced after ^{15}N -CCC diets were withdrawn. These results suggest that hens might transfer excess dietary ^{15}N -CCC or its metabolites into eggs and ^{15}N accumulates during egg development. However, by this method it is not possible to determine if ^{15}N is still bound in CCC or in its metabolite products.

Keywords: Atom percentage ^{15}N , chlorocholine chloride, $\delta^{15}\text{N}$, egg

Effects of Mineral Status in the Soil, Forage, Water, Blood, Milk, Urine and Faeces on Milk Production of Lactating, Free-ranging Camels in Northern Kenya

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Mineral status of free ranging camels in Northern Kenya is not well documented, and neither are its effects on camel milk yields. To establish the relationship between the mineral status and milk yield in free ranging camels, soil, forage, water, lactating camel blood, milk, urine and faecal samples were collected over two dry and wet seasons in Laikipia and Isiolo districts of Northern Kenya to assess Ca, P, Mg, Cu and Co status; daily milk yields were measured simultaneously.

The mean daily milk yield in Laikipia camels ($3.1 \text{ l}\cdot\text{d}^{-1}$) was significantly ($p < 0.05$) higher than that of Isiolo ($2.3 \text{ l}\cdot\text{d}^{-1}$). The wet season had higher milk yield ($2.8 \text{ l}\cdot\text{d}^{-1}$) than the dry seasons ($2.7 \text{ l}\cdot\text{d}^{-1}$). Blood mineral concentrations were significantly related with milk mineral compositions ($p < 0.05$) except for Mg. There was a significant ($p < 0.05$) positive correlation between Cu ($r = 0.753$) and Co ($r = 0.552$) status and milk yield. Milk samples from Laikipia also had significantly more ($p < 0.05$) more Co ($0.10 \text{ mg}\cdot\text{kg}^{-1}$) compared to samples from Isiolo ($0.07 \text{ mg}\cdot\text{kg}^{-1}$). However, increase in soil, water and forage Ca and Mg seemed to depress milk yield. Serum Ca and Co was statistically higher ($p < 0.05$) in Laikipia (243.5 and $0.22 \text{ mg}\cdot\text{kg}^{-1}$) than Isiolo (116.3 and $0.11 \text{ mg}\cdot\text{kg}^{-1}$; Ca and Co respectively). Mean soil and water Ca and serum P were significantly higher ($p < 0.05$) during the dry season ($192.9 \text{ mg}\cdot\text{kg}^{-1}$) than the wet season.

Milk yields seem to have been influenced by the levels of serum Cu and Co or the milk demand of Ca and Co. The mean forage and blood P, Cu and Co in both seasons were below the recommended critical levels while Ca and Mg levels are much higher. High levels of Mg may be antagonizing other minerals necessary for milk production. Seasonal variation in milk may have been due to variations in forage availability and/or mineral availability.

Keywords: Camel, milk yield, mineral status, Northern Kenya

Haematological Effect of Using Jackbean (*Canavalia ensiformis*) Seed Meal as an Alternative Protein Source for *Clarias gariepinus*

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Aquaculture grew in global terms at an average rate of 11 % per year between 1984 and 1998. This trend is attributed largely to widespread availability and utilization of aquafeeds. The fishmeal component of aquafeeds however, contribute substantially to its high cost. Many feed ingredient alternatives to fishmeal at varying levels are now being sought. This will enhance a more economically sustainable aquaculture in the current millennium. Research interest has been directed on the evaluation and use of unconventional protein sources. Jackbean (*Canavalia ensiformis* (L.) DC.) is a fast growing legume widely available in the tropics. The seed has crude protein and amino acid profile that recommend it for use as a substitute for fishmeal in fish feed. It however, has some antinutritional factors some of which can be reduced to a large extent by processing. The study was carried out to evaluate the effect of Jackbean Seed Meal (JBSM) on the haematology of *Clarias gariepinus* when used to replace fishmeal in practical diets of the species. Thirteen isonitrogenous (CP 30) and isocaloric (ME 2900 kcal/kg) diets were formulated by substituting fishmeal in a control diet with raw and 60 minute-boiled JBSM at 10 %, 20 %, 40 %, 60 %, 80 % and 100 %. The test diets were assigned randomly using completely randomised design (CRD) to duplicate groups of 20 fish of average total length 18 cm in 20 litre plastic aquaria. The fish were fed once daily for 8 weeks at 3 % body weight. The static water used in rearing was replaced every 3 days. Blood samples were collected from fish tranquilized with MS222 at the commencement and subsequently bi-weekly for determination of some haematological parameters. Results obtained showed that the haematocrit (PCV), red blood cell count, white blood cell count and haemoglobin concentration decreased significantly ($p < 0.05$) with increasing dietary levels of JBSM. Though boiling JBSM significantly ($p < 0.05$) improved the haematological values of fish fed such diets, the values were still significantly lower than those fed the control diet. The haematological values of fish fed diets with JBSM however, remained within the normal range for *C. gariepinus* BURCHELL, 1822.

Keywords: *Canavalia ensiformis*, *Clarias gariepinus*, haematology

Utilisation of Dried Malt Residue as Dairy Cattle Feed

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The study was conducted to determine the chemical composition of dried malt residue and its effects when supplemented at 0, 20, 30 and 40 % in diets for dairy cattle. Apparent digestibility of experimental diets was studied both conventionally and by the indicator method. Titanium oxide was used as the marker. Four Thai crossbred native × Holstein Friesian cows, fitted with rumen, duodenal and terminal ileum cannulae were used. Rumen pH, ammonia nitrogen and volatile fatty acid concentration were measured. The dried malt residue had 85.95 % DM and the nutrient profile in percentage of DM was: 80.19 % organic matter, 18.55 % crude protein, 2.32 % ether extract, 13.13 % crude fibre, 51.85 % neutral detergent fibre and 22.69 % acid detergent fibre. Dry matter digestibility on 0, 20 and 30 % dried malt residue diets were not significantly ($p > 0.05$) different. Total digestible nutrients, gross energy, metabolisable energy and net energy for lactation on 0, 20, 30 and 40 % dried malt residue diets were not significantly ($p > 0.05$) different but tended to decrease at higher levels of dried malt residue. Dry matter, organic matter and crude protein digestibility in the small intestine on the control diet were significantly ($p < 0.05$) higher than on the 30 and 40 % dried malt residue diets. Crude protein flow to duodenum was not significantly ($p > 0.05$) different across diets. Rumen pH was not different across diets. However, ammonia nitrogen levels in the rumen, 1 hour after feeding in 0, 20 and 30 % dried malt residue diets were significantly ($p < 0.05$) higher than on the 40 % inclusion diet. At 3 hours post-feeding ammonia nitrogen level in the diet with 30 % dried malt residue inclusion was significantly ($p < 0.05$) higher than on 0, 20 and 40 % dried malt residue inclusion diets. Total volatile fatty acid concentrations in 0, 20, 30 and 40 % dried malt residue diets tended to decrease at higher levels of dried malt residue although this did not reach significance ($p > 0.05$). However, acetic to propionic acid ratio in 30 % dried malt residue diet was significantly higher than at 40 %. It could be economical to incorporate dried malt residue in certain circumstances of dairy feeding.

Keywords: Dairy cattle, dried malt residue

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Effect of Replacing Yellow Maize with Sweet Potato in Diet on Performance of Piglets in Lower Mekong River Basin of Cambodia

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Fertile basin irrigated by Mekong River, where the major staple food crops and vegetables were planted, provided an important source of Cambodian economic. Sweet potato, one of the energy-providing crops, is being cultivated mostly on this land. Surplus of yield is a profound problem whilst it had to be harvested prior flooded period. While sun-drying sweet potato tuber is less palatable for human consumption, utilization in animal diet, therefore, become an objective of this study. An experiment was carried out in the animal experimental station of the Royal University of Agriculture, Cambodia, for 15 weeks to determine the effect of replacing yellow maize with sweet potato in the diet on the performance of weaned piglets. Under completely randomized design, 32 six week old piglets, with 7.61 kg (SEM 0.8) in initial body weight, were divided into 4 groups A, B, C and D, with four replications. Diets were assigned by subtracting yellow maize mixed 42% in the diet with sun-dried sweet potato tuber in the level of 0, 20, 30 and 40%. Body weight of piglets in group B (28.94 kg) was found to be better than those in A (23.46 kg), C (23.29 kg) and D (25.16 kg) ($p < 0.01$). While the average daily feed intake in gram among groups was not detectable (608.11, 651.62, 607.95 and 652.96 of A, B, C and D respectively), it was investigated that feed conversion ratio was lower in group B (3.72) followed by A (4.56), C (5.20) and D (4.40) respectively. Moreover, unless sweet potato was charges, the gross economic gained of group B was better than the other groups. It is concluded that utilization of sweet potato in the level of 20% in piglet diets is an optimum amount for farmer income.

Keywords: Piglets, sun-dried sweet potato, yellow maize

Effect of Rice Bran Replacement with Treated Cassava Peel (CaP) in Diets on Growth Performance of Indonesian Indigenous Sheep

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A study was conducted to investigate the effect of replacing dietary rice bran with treated cassava peel (CaP) on the growth performance of Indonesian indigenous sheep. Twenty-four indigenous sheep each weighing 12.49 ± 1.27 kg were in a Completely Randomized Design assigned to one of 4 treatments diets. The control diet (diet 1) was 25 % Napier grass and 75 % concentrate containing 15 % molasses, 16.73 % coconut cake, 1.5 % CaCO_3 , 1.5 % premix, 0.27 % urea and 40 % rice bran. The rice bran was in diet 2 replaced with 40 % fresh CaP, in diet 3 with 40 % boiled CaP and in diet 4 with 40 % CaP fermented with *Saccharomyces cerevisiae*. Content of coconut cake and urea were adjusted to make all treatment diets iso-nitrogenous and isocaloric. Feed intake, daily body weigh gain, and feed conversion ratio (FCR) were measured. The feed intake of sheep fed diets 1 (control), 3 and 4 did not differ ($p > 0.05$). However, that of diets 2 differed with 1, 3 and 4 ($p > 0.05$). Mean feed intake was 693.87 g/day, 833.95 g/day, 733.40 g/day, and 662.40 g/day for diets 1, 2, 3 and 4, respectively. Average daily gain of sheep fed diet 4 was higher than that of sheep fed diets 2 and 3 but not different from diet 1. The average daily gain was 77 g/day, 65 g/day, 76 g/day and 96 g/day for sheep fed diets 1, 2, 3 and 4 respectively. Diet 4 FCR did not differ ($p > 0.05$) from that of sheep fed diets 3 and 1, but differed from that of diet 2. Mean of FCR was 9.01, 12.83, 9.65 and 6.90 for diets 1, 2, 3 and 4, respectively. It was concluded that treated CaP especially fermented CaP may replace rice bran in diets for improving performance of Indonesian indigenous sheep.

Keywords: Growth performance, indigenous sheep, rice bran, treated cassava peel, Indonesia

Diversity and Abundance of Intertidal Crabs at the East Swamp – Managed Areas in Segara – Anakan Cilacap, Central Java, Indonesia

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Mangrove forests possess a high diversity and abundance of crabs in Central Java. The conversion of mangrove forests into prawn ponds causes depletion of supply of river sediments and loss of property. The main objective of this study is to compare the diversity and abundance of intertidal crabs in undisturbed areas, crab hunting areas, logging areas and prawn pond areas that were different in percent mangrove canopy covers and percent sediment textures. In each area, two transect lines were installed to analyse the percent mangrove canopy cover and the percent sediment texture compared to a trilinear plot. Intertidal crab samples were taken at random and analysed by the program of “Estimate S” to get information on diversity indices. The research was carried out from October 2000 to January 2002.

In total, 16,353 intertidal crab individuals in 13 species were sampled. Differences in observed number and estimated number of species (ACE, Chao⁻¹), as well as number of individuals, diversity indices and evenness between the four studied mangrove areas were all highly significant. Monthly fluctuation the intertidal crab diversity was more constant in the undisturbed area with a high mangrove coverage (90%) compared to the crab hunting area, the logging area and the prawn pond area with a coverage of 89%, 33% and 0%, respectively. Intertidal crab abundance was equal in three areas, but significantly lower in the completely deforested prawn pond area.

These results underline the necessity for a combination of economic and natural resource management. Silvofishery leading to the complete clear-cutting of mangrove trees (as in the prawn pond areas) leads to a highly impoverished crab community both in terms of crab individuals and species. Furthermore, the maintenance of undisturbed areas should be a primary objective for the management, since it represents a more constant crab diversity and highest abundance, and sustains the protection of rare species such as *Neoserratium* sp..

Keywords: Abundance, Central Java, diversity, intertidal crabs, mangrove, sediment

Driving Factors for Animal Husbandry in Communal Areas of Namibia and South Africa — First Empirical Results

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In an environment where cropping is restricted by low and erratic rainfall, animal husbandry can contribute to food security. Animal functions utilized in traditional pastoral systems are generally storage of wealth, regular output and status display. A well-managed mobile system does not harm the environment. In southern Africa, abrupt and ongoing changes in political, social and economic frame conditions limit the opportunities for continuous adaptation, and, as a consequence, non-controlled livestock systems are more likely to threaten the environment. Little is known about the characteristics, functions and impact of recent stationary animal production systems in communal areas of Namibia and South Africa. Embedded within the Biodiversity Monitoring Transect Analysis in Africa (BIOTA project), this study aims at contributing insights into livestock systems relevant to the analysis of the environmental gradient. Three communities were selected along a transect reaching from the Okavango River to Cape Town and household surveys were conducted. The communal use of the range started in all cases relatively recently because of land allocations in the last 3 to 30 years. The ecological conditions, the historical development, the prevalent ethnic group, and the rights and agreements for use and access differed. Several livelihood combinations of crops with small or large stock have evolved, as well as varying dependency on income from livestock. Trade with animals ranged from reluctance to sales, even when forage was scarce, to a commercially oriented way of stock keeping. Off-farm incomes, generated via absenteeism and governmental transfer payments, were crucial for the living of several households. First results of the importance of explanatory variables for the differences in husbandry characteristics will be presented in the full paper.

Keywords: Communal land use, household survey, livestock systems, Namibia

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ELISA and Other Tests in Diagnosis of *Pasteurella multocida* Infection in Camels in Egypt

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The bacteriological examination of internal organs from 14 dead camels had severe respiratory symptoms revealed the isolation of *Pasteurella multocida* (PM) from 86.6 % of the collected organs (52 out of 60) *P. multocida* subspecies *multocida* (PMM) (serotype B) represented 85 % of the isolates, while *P. multocida* subspecies *septica* (PMS) (serotype A) was isolated only from one lung specimen (1.7 %). Nasal swabs and blood specimens from clinical cases and contact apparently healthy camels showed similar isolation patterns. PMM serotype (B) was isolated in 85.9 %, 65.6 % and 30.4 %, 8.1 % respectively, while PMS serotype (A) was isolated from clinical cases only, 3.1 % and 1.6 % respectively. PMM serotype (A) was also isolated from nasal swabs of contact apparently healthy camels (3 %).

Indirect hemagglutination test (IH) showed higher PM antibody titers in the serum of clinical cases reached 1:512 in 17.2 % of the clinical cases against 0 % in contact apparently healthy camels. In Dot immunobinding assay (DIA), 95.3 % of serum samples from the clinical cases were tested positive with an optical density (OD) range from 0.59 to 1.17, whereas only 4.7 % were tested negative. Serum samples from contact apparently healthy animals showed 72.6 % positive results, whereas 27.4 % were negative. Serum IgG-ELISA revealed PM antibodies in 96.9 % of the clinical cases with OD range from 0.66 to 1.63. Two clinical cases were tested negative (3.1 %). In contact apparently healthy camels, 75.6 % of the samples were tested positive with a lower OD range, while 24.4 % of the samples were negative. Nasal secretion ELISA revealed the presence of PM antibodies in 95.3 % of the nasal secretions from clinical cases with OD range from 0.62 to 1.27 while 4.7 % of the samples were negative. Contact apparently healthy camels showed positive results in 74.1 % of the samples, with OD range from 0.62 to 1.03, whereas the negative represented 25.9 %.

Serum biochemical analysis showed significant decrease in total protein, albumin as well as A/G ratio, while the globulin fraction was increased. The enzyme activity of ALT, AST, alkaline phosphatase as well as the values of creatinine, urea and uric acid were significantly increased. Minerals profiles were also altered, calcium, phosphorus, magnesium, sodium, chloride were significantly decrease, whereas potassium increased. It was concluded that serum IgG-ELISA was superior to nasal secretion IgG-ELISA, DIA and IH which can also assess in the diagnosis of PM infection in camels in conjunction with serum biochemical parameters.

Keywords: Camel, Dot immunobinding assay, indirect hemagglutination, nasal discharge ELISA, *Pasteurella multocida*, serum ELISA

Reproduction Rate of Kacang and Peranakan Etawah Goats under Village Production Systems in Indonesia

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Small ruminants like sheep and goats are important for a larger part of the Indonesian rural population. The existing goat husbandry is normally the result of hundreds of years of tradition. The major feeding systems in goat production found in Indonesia are the cut and carry and grazing systems. The number of goats raised per farm is relatively small. Goats are kept primarily for meat production, so production traits of interest are the number of young weaned per breeding female per year and their growth rate. The evaluation of the reproduction rate of local and adapted breed of goats can provide important information to understand its productive potential using local resources. The major breeds of goats found in Indonesia are the Kacang and the Etawah goats. Indonesia is situated roughly between 6° to 11° north latitudes and 95° and 141° east longitudes. The temperature stays within a constant range, 23–31°C daily in the low plains and 18–27°C in the inferior plateau. Reproduction data of 173 and 189 Peranakan Etawah and Kacang does, respectively, were collected through on-farm research over 20 months in smallholders agriculture located in Central Java, Indonesia. At every reproductive event, date and number of the animal concerned were recorded. Parity, type of birth and litter weight at weaning were identified on reproduction rate of Peranakan Etawah and Kacang goats. General linear model were applied in the data analysis. The average reproduction rate of Kacang and Peranakan Etawah does was 2.95 and 1.76 kid / doe / year, respectively. Least squares analysis of variance reveal that doe reproduction rate was significantly affected by parity, type of birth and litter weight at weaning. The reproduction rate of Kacang and Peranakan Etawah does tended to increase with the advance in parity up to the 4th parity and slightly decrease thereafter. The reproduction rate increased progressively with the advance in birth type. Results also demonstrated that at each 1 gram increase in litter weight at weaning there was an increase of 0.17 and 0.08 reproduction rate of Kacang and Peranakan Etawah does, respectively.

Keywords: Goat reproduction, Indonesia, kacang goat, peranakan etawah goat

Soybean Straw Replacing Low-Quality *Brachiaria* Grass by in Forage-Concentrate Diets — Effects on Performance and Carcass Quality of Lambs

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There is an increasing demand for lamb meat in Thailand. In the north of Thailand, soybean is planted and soybean straw is a major by-product, thus providing an alternative to the typically low-quality pastures and hays from those pastures. In this study the effects on performance and carcass quality of lambs fed different levels of soybean straw partially or totally replacing low-quality *Brachiaria ruziziensis* grass hay as a model for grazing were evaluated. All diets were supplemented with concentrate (1/3 of diet) thus reflecting more intensive feeding systems of somewhat larger farm enterprises of the north of Thailand. Twelve male indigenous lambs of 30 kg body weight were fed one of the three diets for 179 days. Diets differed in forage with *Brachiaria* hay being replaced to 0.50 and 100 % by soybean straw. Lambs were slaughtered and the right carcass side was dissected as is common in Thailand and the left carcass side was dissected according to US standard. Average daily gain of the lambs fed only soybean straw as a forage was superior to that of the other two groups, this probably due to the higher protein content of the soybean straw compared to the grass hay and the lower amount of feed refusals. Feed conversion ratio and feed cost per gain were improved as well by the use of soybean straw. Carcass weights and dressing percentage were more favourable in lambs receiving only soybean straw or only *B. ruziziensis* hay than in those receiving an 1:1 mixture. There was a trend to higher lean meat percentages with increasing proportion of soybean straw. Carcass cutting in Thai style with the aim to dissect the valuable muscles without bone, fat and connective tissue around the muscle did not result in significant difference among groups, but lambs dissected according to the US standard cutting scheme resulted in superior percentages of loin, rib and plate when lambs received the mixed forage while there were no obvious differences in the other valuable cuts. This has important implications for export.

Keywords: *Brachiaria* grass, carcass quality, soybean straw

A Methodology to Identify the Role of Local Institutions in Livestock Breed Development — A Case Study from West Africa

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Animal breeding activities have an important social dimension and depend to a large extent on institutional and human capacities to coordinate and interact. Despite the highly advanced institutional environment that is known to have considerably contributed to the impressive productivity increases in the North, the social characteristics of local animal breeding systems in the South have rarely received attention in research and development for breed improvement. Effective livestock development and breed improvement strategies for better animal genetic resource management are increasingly required. Methods need to be made available that enable outsiders of diverse professional background to gain better insights into traditional breeding systems and their respective institutions to facilitate the cooperation with livestock owners and other stakeholders.

A methodological approach based on an action-oriented analysis of local institutions was developed for the systematic assessment and evaluation of the institutional and organisational environment in which livestock breeding activities are carried out. Emphasis is put on local level institutions and organisations and the existing local knowledge base. Participatory tools are used that enable the livestock keeping communities to analyse their situation. As part of a larger study, a sub-sample of cattle herd owners from 13 villages in The Gambia described the relative importance of institutions, their functions and the degree of interaction among individuals, the community and the institutions and organizations relevant to their cattle enterprise. The analytical process was assisted through visualization by depicting the institutions, organizations and their linkages in diagrams. Key-informant interviews were additionally held with other stakeholders.

The methodology produced extremely relevant information directing a breed development intervention. The intervention must respond to the considerable demand for certified quality male breeding stock and adverse effects of intense competition among cattle herd owners. Information is usually not shared among herd owners and breeding knowledge only passed on within the larger families. A considerable share of program resources has to be invested in strengthening local institutions and breeders' associations, as few traditional institutions were perceived to function well.

Keywords: AnGR management, animal breeding, institution analysis, institutional development

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Use of Essential Oil Extracted from Citronella, Cloves and Peppermint as Supplement in Weaner Pig Diets

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The experiment was conducted at Chiang Mai University, Thailand to determine the effect of supplementing essential oil from citronella, cloves and peppermint as feed additives in weaner pig diets. Thirty weaner pigs (28 days old; 9 ± 0.8 kg) were selected and randomly divided into five groups of six animals each. Each weaner pig was housed in an individual pen. Each group was allocated to one of the dietary treatments: Diet 1. control basal diet, Diet 2. basal diet with amoxicillin as antibiotic (2 g kg^{-1} diet), Diet 3. basal diet with citronella oil (5 ml kg^{-1}), Diet 4. basal diet with clove oil (5 ml kg^{-1}) and Diet 5. basal diet with peppermint oil (5 ml kg^{-1}). The design was completely randomized. Diets were formulated to meet NRC (1998) standards. The growth performance and faecal characteristics were determined for 35 days. Averaged daily gain (ADG) and feed conversion ratio (FCR) of pigs fed the diets 1 to 5 were: 450, 460, 460, 450, 440 g d^{-1} and 1.79, 1.68, 1.70, 1.71 and 1.76, respectively. There was no significant ($p > 0.05$) differences in ADG, FCR and average daily feed intake amongst the treatments. The faeces of the pigs fed diets with essential oil had significantly ($p < 0.05$) better shape and colour than pigs fed the control diets but there were no significant ($p > 0.05$) differences with the pigs fed the diet supplemented with amoxicillin. The incidence of diarrhoea in the pigs within each treatment group as a percentage were: 48.10, 10.00, 4.29, 25.71 and 22.86 on diets 1 to 5, respectively. It is concluded that the application of citronella oil as feed additive has potential in feeding weaner pigs.

Keywords: Citronella oil, clove oil, essential oil, peppermint oil, weaner pig

Approaches on Conservation, Exploitation and Sustainable Use of Animal Biodiversity in Vietnam

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Vietnam is one of 15 countries in the world richest in genetic resources covering of an area of 330,000 km². Vietnam fauna is known of 275 species and sub-species of animals, 1,026 species and sub-species of birds, 260 species of reptiles, 32 species of amphibious, 500 fresh water fishes, about 2,000 sea water fishes, and dozens of thousands of non-spine fauna. Endemic Vietnamese fauna are numerous, including dozens of mammals, 10 species of birds, 60 fishes, etc. Vietnam is considered as one of the world ancient animal domestication area. The husbandry animals here include 12 species: pig, cattle, goat, sheep, sika deer, samba deer, rabbit, chicken, duck, muscovy-duck, geese and pigeon. They generally maintain adapting characteristics to the living environment. But many of the local breeds are facing extinction or endanger. The conservation duty focuses on protection and strengthening of production sustainability. The main issues are rehabilitate and maintain animal races that are in extinction risk, prevent races extinction; improve in-situ conservation in native areas, promote conservation through use; maintain in-vitro genetic materials of specially necessary races to avoid inbreeding. Approaches to conservation and sustainable utilisation of animal genetic resources from 2001–2010.

- Raising community awareness of position and importance of animal biodiversity.
- Linking animal biodiversity conservation to national culture conservation.
- Defining proper economic mechanism and regulation for biodiversity conservation.
- Developing and perfecting legal documents on animal biodiversity conservation.
- Scientific training program relevant to the science and technology in animal genetic conservation, Developing the National Animal Genebank.
- Enhancing of conservation network from officials to grassroots.
- Transforming market potential breeds in to production by political supports for long-term breeding programs.
- Publishing Domestic Animal Diversity Information System (DAD-IS) on Internet standardized by FAO.

Keywords: Sustainable use, Vietnamese animal diversity and conservation

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Digestibility and Nitrogen Retention in Creole Pigs and Improved Breed of Pigs Fed with Maize and Mucuna Beans in Peasant Systems in South of Mexico

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Peasant pig production in South of Mexico is primarily characterised by Creole pigs (CP) kept in the backyard. CP are however more and more displaced by improved breeds of pigs (IBP). Often, peasant people believe that IBP are more profitable than CP because of their higher weight gain and leaner carcass. However, to exhaust their growth capacity the IBP have high nutrient requirements. On the other hand, the low performance characteristics of CP may match better with the feed available in peasant production such as mucuna beans (*Stizolobium deeringianum*). The objective of this experiment was to evaluate digestibility and nitrogen balance in CP and IBP fed with feedstuffs obtainable in peasant systems.

Eight CP and eight IBP pigs with a mean live weight of 40.7 ± 1 kg were used. The pigs were housed in metabolism crates. Two experimental diets were used: diet (A) maize only (crude protein 8.2%), diet (B) 25% of mucuna beans previously boiled and dried + 75% of maize (crude protein 12.3%). Seven days were allowed for diet adaptation and seven days for faeces and urine collection. The pigs were allocated to one of two dietary treatments in a randomised block design with four blocks and one replication per treatment in each block. Data were analysed using the GLM procedure of SAS.

CP showed a higher dry matter intake and live weight gain than IBP ($p < 0.05$). The intake of dry matter within the breeds was not influenced by the different diets. Digestibility of dry mater was similar ($p > 0.05$), however digestibility of neutral detergent fibre was higher in diet B. There were no statistical differences in nitrogen retention ($p > 0.05$). The results indicate that there is no benefit in use IBP when only low quality diets are available. It is possible to use mucuna beans in order to reduce maize in pig diets.

Keywords: Creole pigs, digestibility, nitrogen balance, *Stizolobium deeringianum*

Effect of Selenium Chelate Inclusion in Growing-Finishing Pig Diet on Productive Performance and Residual Selenium in Blood Plasma, Internal Organs and Lean Meat

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Selenium is normally included in pig diets in the form of sodium selenite or selenium enriched yeast to prevent deficiency problems and improve production performance. However, high levels of selenium can result in lower production performance and residual selenium in swine tissue can affect the consumer.

This experiment was conducted at Chiang Mai University to study the effect of selenium in the form of selenium-chelate (selenoglycine) included at levels of 0, 0.15, 0.30 and 0.60 ppm in growing and finishing pig diets. 48 pigs were divided into 4 treatments of 12 animals each and fed with the experimental diets ad libitum for 72 days in a completely randomized design. Blood samples were taken from the Jugular vein at 30-day intervals. Internal organs and lean meat were collected at the end of the experiment. The samples were analysed for selenium concentration. Average daily gain and feed conversion ($\text{g gain kg feed}^{-1}$) were slightly higher as level of selenium increased (649, 672, 696 and 752 g d^{-1} and 305, 305, 325 and 335, respectively) but there was no significant difference ($p > 0.05$). Daily feed intake across diets was 2.15, 2.20, 2.12 and 2.23 kg d^{-1} , respectively. Blood selenium after both 30 and 60 days of feeding increased significantly ($p < 0.01$) as level of selenium in the diets increased and prolonged feeding duration tended to increase residual selenium in the blood. Residual selenium was found in internal organs, heart, lung, liver and kidney which increased with increased level of selenium inclusion in the diets and was significantly ($p < 0.05$) highest at 0.60 ppm of selenium compared to the rest of the treatments. Kidney and liver contained the highest amount of residual selenium. Residual selenium content in lean meat increased with increase in level of selenium in feed. It can be concluded that supplementation of selenium as selenium chelate (selenoglycine) can slightly improve productive performance but residual selenium in internal organs and lean meat may be harmful to the human if the selenium level in the diet is high.

Keywords: Internal organs, lean meat, productive performance, residual selenium, selenium, swine

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Site and Extent of Cottonseed Meal Protein Digestion Substituted for Soybean Meal in Concentrate Diets of Steers

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Cottonseed meal (CSM) is by product and can be obtained from cotton fiber and cottonseed oil industry. Compared to Soybean meal (SBM), CSM contains slightly lower amounts of crude protein (CP) and energy, but is higher in fiber and rumen undegradable protein (RUP).

The experiment was conducted at Chiang Mai University, Thailand, to determine the nutrient quality of CSM substituted for SBM in steer diets in a 4 × 4 Latin Square Design. Each steer was fitted with rumen fistula, and cannulae at duodenum and ileum. The steers were fed concentrate diets containing CSM substituted for SBM as protein source at levels 0, 50, 75 and 100 %. Diets were fed at 3 % BW and contained 50 % rice straw and 50 % concentrate diet. TiO₂ was used as indicator for this experiment. Digestibility of dry matter (DM), organic matter (OM) crude protein (CP) and true protein (TP) at rumen, small intestine, large intestine and total tract were determined. The amount of free gossypol in concentrate diets were 0.01, 0.07, 0.12 and 0.14 % of DM respectively. There was no apparent health disorder during the experimental period. DM and OM digestibility based on the amount of intake at rumen, small intestine, large intestine and total tract were not significantly different among treatment groups. There were no significant differences in the amount CP increased in rumen. The amount of digestible CP and TP in small intestine and its digestibility based on the amount entering small intestine were not significantly different. There were no effects in ruminal pH and NH₃-N (11.32, 12.93, 10.29 and 10.46 mg/100ml). It was concluded that CSM could substitute SBM as protein source in concentrate diets up to 100 % without any symptoms of gossypol toxicity and had similar values of DM, OM, CP and TP digestibility, ruminal pH and ruminal NH₃-N to SBM.

Keywords: Cottonseed meal, gossypol, large intestine, nutrient digestibility, rumen, small intestine, soybean meal, TiO₂, total tract

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Do Technological and Policy Developments Further the Conservation and Use of Genetic Resources?

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Over the past decade substantial progress has been made in the development of a political framework for the conservation and sustainable utilization of agrobiodiversity. The conclusion of the Convention on Biological Diversity (in 1992) and, more recently in 2001, the International Treaty on Plant Genetic Resources for Food and Agriculture have been key developments, both addressing the urgent need for long-term conservation of threatened genetic resources world-wide. At the same time advances in molecular genetics and information technologies have been dramatic. Both areas are very relevant to conservation and the sustainable utilization of these resources.

Coinciding with the aforementioned developments the world experienced the impact of the globalization of economies and a drastic shift in the property rights regime, in particular the use of patents to protect biological inventions/discoveries. The impact of globalization can be observed on the one hand in a drastically reduced number of private plant breeding companies, and an increased importance of genetically modified (GM) varieties in food production for the major crops, on the other. The implications for conservation of the use of GM varieties are yet to be studied and policies are still to be developed to promote reliable *in situ* and *ex situ* conservation efforts.

The above-mentioned developments coincided with the degree of governmental support to agricultural research, including activities such as pre-breeding and conservation, particularly in developing countries. At the same time these countries also lack the financial resources to exploit the locally available genetic diversity. Moreover, the technologies and the required human resources are similarly lacking and thus, the benefits of these technological developments do not reach the main guardians of agrobiodiversity, i.e. the farmers. This, in turn, does not provide them with any real incentive to contribute towards conservation activities.

In the above context this paper will study the need and the conditions for strategic partnerships between developing countries, the private sector and national and international agricultural research institutions, to achieve both reliable, efficient long-term conservation efforts and sustainable utilization activities for the benefit of all. The role of genebanks and of the Global Conservation Trust will be given special attention.

Keywords: Conservation, genebanks, genetic resources, partnerships, policy framework, technologies, utilization

Plant Species Diversity of Homegardens in Humid and Semiarid Cuba and Its Importance for Self-sufficiency of Households

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The cultivation of different plants in homegardens for self-sufficiency has a long tradition in Cuba, but knowledge about homegardens in Cuba is small. To analyse this more deeply, cultivated plants of 31 homegardens were surveyed in three villages in eastern Cuba in 2001. Two of the study villages were located in a humid area with an annual precipitation of about 2200 mm. The third village was situated in a semiarid area with about 450 mm precipitation. The similarity of species composition between the three study villages was calculated with the Sørensen coefficient of similarity. The plants studied in the homegardens included those for human consumption such as fruits, vegetables, tubers and cereals as well as spices and medicinal plants. Most homegardens were characterised by an agroforestry system with three vegetation layers. In total, 101 different plant species were found with an average number of 18 to 24 species per homegarden for the three villages. The minimum was seven different species in a homegarden and the maximum 49 species. Half of the species surveyed have a medicinal potential and thus enable in-situ conservation of genetic resources. A broad range of species was found in all villages, because irrigation is used under semiarid conditions, which allows the cultivation of species preferring more humid conditions. This results in a relative high similarity in species composition between the villages. Highest similarities were found for fruit trees and tubers, whereas spices and medicinal plants were lowest in the comparison between the humid and semiarid villages. Nevertheless, some species were exclusively found under semiarid or humid conditions. In general, homegarden production provided a broad and diverse basis for self-sufficiency of the households. Although homegarden production showed to be only a small source of income, it is particularly important because of low-paid outside work and minimal food provision of the state.

Keywords: Caribbean, cultivated plants, food supply, households' income, medicinal plants, species richness

Economic Analysis of Farmers' Preferences for Coffee Variety Traits — Lessons for on-Farm Conservation and Technology Adoption in Ethiopia

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The knowledge to-date recaps *Coffea arabica* to have originated in Ethiopia and its genetic diversity in the country is proved to be high. On top of its role in the national economy, Ethiopia's coffee diversity is important not only nationally but also in international research and conservation centers. However, this diversity is dwindling due to policy, institutional and market failures. Despite a tremendous attention to salvage this degradation through the emerging on-farm conservation, there is no adequate contextual research done as to how this strategy can be harmonized with farmers' livelihood strategies and how policy can face the potential trade-off with modern technology adoption.

To implement sensible on-farm conservation and variety adoption strategies, farmers' preferences for variety traits and their land allocation behavior should be understood. To this end, the paper aims to study coffee farmers' preferences for variety traits and examine land use decisions (between traditional and improved coffee trees). A household model that considers farmers' variety trait preferences as a positive externality of their livelihood decisions is developed drawing from Lancaster's characteristics model.

The data come from 266 coffee growing farmers in South Western Ethiopia. Multi-nomial logit and two-limit Tobit regression models are estimated to examine farmers' preferences for coffee variety traits and the proportion of coffee land that they allocate to traditional coffee trees, respectively.

The results have shown the factors inducing farmers' preference for certain variety traits, relative importance of coffee variety traits to farm households of different features, and factors motivating farmers to continue planting traditional coffee trees. Based on the empirical results, the paper derives policy implications in the areas of on-farm conservation, improved variety adoption, and coffee breeding priority setting.

Keywords: Coffee diversity, Ethiopia, multi-nomial logit and two-limit Tobit models, on-farm conservation, variety adoption

Cultural Impacts on Natural Resource Management in the Lore Lindu Region, Central Sulawesi

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The Lore Lindu National Park in Central Sulawesi represents uniqueness in biodiversity with a huge number of endemic flora and fauna species. However, increasing logging and expansion of agricultural land into the national park endanger the biodiversity and a sustainable land use. In order to understand the current process in the region, the cultural and historical aspects of natural resource management are indispensable. As a result of an empirical qualitative study carried out within the frame of the collaborative research program SFB 552 — STORMA, cultural and socio-cultural impacts turn out to be a crucial factor for changes in natural resource management in the Lore Lindu region.

The investigated region hosts three different local ethnic groups: To Kaili, To Kulawi, and To Napu. Moreover, spontaneous migration within the region and from other parts of the archipelago, as well as local and inter-island resettlement programs led, in the course of time, to a complex patchwork of ethnic groups. These ethnic groups are distributed heterogeneously over the Lore Lindu region and within its villages. Thus, ethnic stratification and the distribution of social and cultural power build up diverse schemes of land use patterns by merging cultural impacts of varying strength. The introduction of new crops (e.g. cacao) and land use practices (e.g. use of fertilizer, field size enlargement) as well as the transformation of agro-economic structures (e.g. expansion of wage labor systems) by migrants from outside the study region are only two major fields of this study. However, also the direct and indirect effects of the Dutch colonial rule (e.g. enforcement of the production of cash crops like copra or the abolishment of livestock consuming ceremonies) can be regarded as cultural impacts. The empirical evidence reveals the decisive relevance of cultural aspects in terms of natural resource management in the Lore Lindu region.

Keywords: Ethics, cultural factors, land use, biodiversity, Sulawesi

Exploration and Geographical Trait Diversity in *Vernonia galamensis* — A Potential New Industrial Crop for Dry Regions

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Vernonia galamensis is a new potential industrial crop with very high content of vernolic acid (12, 13-epoxy-cis-9-octadecenoic acid) in the seed oil. The species is limited in distribution and endemic to drier parts of East African countries. In order to study the existing eco-geographical and morphological diversity and seed quality traits diversity in Ethiopia, germplasm collection and field evaluation were carried out. A total of 480 accessions were collected, in all regions where *Vernonia* is growing. Altitude of collecting sites varied between 1,250 and 2,050 m, soil pH from 5.1 to 8.5, the most common soil type was sandy loam, and the organic matter content varied from 0.2 to 12.9 %. The mean vernolic acid content of the seed oil of the accessions was 74 %, and ranged from 34 to 87 %. Shannon-Weaver Diversity Index (H') showed that most traits are polymorphic and the highest H' was noted for internode size (0.93) and the lowest for stem color (0.47). The overall diversity index for all traits was 0.76. The majority of the genetic diversity, 89 % and 95 %, was observed within region of origin and altitudinal group, respectively. Clinal pattern of variation was observed for traits such as flower color from purple to white, stem color from purple to green in the direction of lowland to highland. Principal component analysis and dendrogram constructed from H' indicated the close relationship of Sidamo and Shewa regions and the large difference of introduced accessions from accessions collected in Ethiopia. It was concluded that regions/altitudinal classes with highest diversity could be suggested for germplasm conservation strategy, either for *in situ* or *ex situ*.

In the collection mission, it was not possible to find *Vernonia* in some locations that were earlier indicated by herbarium specimens collected since 1840. This could be an indication of change in land use system and environmental degradation and, hence, loss of genetic resources of the species.

Keywords: Altitudinal diversity, collecting expedition, dry land crop, new crop, regional diversity, shannon-weaver diversity index, *Vernonia galamensis*

Conservation and Use of Wild Populations of *Coffea arabica* in the Montane Rainforests of Ethiopia

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Ethiopia is the center of origin for *Coffea arabica*, where wild coffee populations are part of the understorey in the montane rainforests. This wild coffee is not only an important gene pool for future selection and breeding of improved cultivars. In the forest coffee areas, about 60 % of the local population earn their livelihood with coffee, which mainly comes from forest and semi-forest coffee systems. Deforestation and land-use change, however, are threatening the wild coffee stands. To prevent the forest and coffee stands from further damage, conservation as well as sustainable use concepts have to be developed. In the framework of “Biosphere Research - inTEgrative and Application oriented Model projects” (BioTEAM), funded by the German Federal Ministry of Education and Research (BMBF), ZEF and the Ethiopian Agricultural Research Organization (EARO) jointly carry out a research project entitled “Conservation and utilisation of wild populations of *C. arabica* in the montane rainforests of Ethiopia”. The project consists of six sub-projects: (1) Studies on the biodiversity of afro-montane rainforests with occurrences of wild coffee populations, (2) Molecular systematics as a basis for managing the genetic diversity of *C. arabica*, (3) Eco-physiological adaptation of wild coffee populations to water stress, (4) Importance of fungal pathogens in wild coffee population of Ethiopia and potential of resistant coffee types, (5) Economic assessment of the gene pool of *C. arabica* and the economic potential of conservation and use concepts with special consideration of the rain forest habitats, and (6) Analysis of institutional factors influencing the conservation and use of *C. arabica* gene pool. The project approach will be presented.

Keywords: BioTEAM, *Coffea arabica*, economic valuation, ecophysiology, Ethiopia, genetic diversity, institutional research, montane rainforest, phytopathology, species diversity

The Efforts to Fulfill the Requirement of Lily Seed Bulb and its Breeding Approach

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In Indonesia, lily flower has a good economic value. It was cultivated by the small farmers as well as commercial farmers. Unfortunately, seed bulb procurement still depends on imported lily seed, which was so expensive and its varieties were limited. This is the reason why the small farmers cultivated only the white local lily.

Imported seed bulb which has been generated for so many years was able to be publicly multiplied and this can be used as a source for in vitro rapid multiplication research that would produce seed bulb for the small farmers. Cross breeding programme was required to produce new variety. This study has been conducted in the laboratory, screen house, and in the field. Laboratory work included: (a) in vitro multiplication that provides information about appropriate kind of explants and media that would be used as a blueprint for lily in vitro multiplication, as well as plantlets for acclimatization study, and for further multiplication; (a) in vitro conservation study is important related to the procurement of plant resources and provide information about existing interaction between medium and plantlet genotypes. On the other hand, those researches will support hybridization or cross breeding programme. Hybridization was done in the screen house. Heterogeneous F_1 's seed was cultured in vitro to provide F_1 's plantlets. The F_1 's plantlets were multiplied in vitro in order to maintain genetic variability of F_1 's plantlets, so it will create variability of population. In the screen house the acclimatization study was also conducted to provide information as a blueprint for lily plantlets acclimatization. For field study the farmers involvement was quite innovative to conduct his activities using his own special technology to cultivate lily plant, as the result of in vitro multiplication. In fact the farmer was able to show good talent to cultivate in vitro lily plant, which produce lily flower that ready to market for one planting period. The farmer was also able to help in F_1 's genotypes selection. On the following research this farmer will also engaged to produce a large number of seed bulb that will be used by other farmers. Furthermore, rapid multiplication trough callus and in vitro breeding programme would be able to be conducted.

Keywords: Breeding approach, lily, requirement of seed bulb

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Farming Systems and Regional Natural and Economic Stability Issues in the Mata Atlântica, Brazil

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The natural environment of the Atlantic Rainforest of Brazil, the Mata Atlântica, has been exposed to competing intensive exploitation for centuries. Low natural production risks, reliable rainfall and perennial water courses as well as profound and fertile soils, have favoured the establishment of intensive land use systems. Intensities and extension of land use have resulted in negative external effects, such as effecting water resources quality and reliability, and reducing the natural system stability within the remaining fragments of the forest systems.

The approach of a cluster research project in the south-eastern region of the Mata Atlântica has identified the following major issues in regional development:

- How to preserve forest areas and biodiversity considering spatial aspects of natural functionality for the totality of the economic and natural systems?
- Preservation strategies in this context might involve permitting controlled economic exploitation by land users.
- How to internalize external effects of agricultural land use while preserving economic sustainability of the farming system and of regional development?

An incentive system has to be established to influence farmers' behaviour. The success of such an incentive system depends very much on understanding farming systems interactions, internal interactions as well as the specifically focused interaction with the bordering forest systems. This can be achieved by assuming a farming system approach which considers the decision situation and the resource allocation problems of a farm household.

For analysing the environmental impacts of agricultural systems on natural resources such as biodiversity and ecosystem stability, water and soil, they need to be assessed on aggregate level. The challenge in optimising Mata Atlântica preservation strategies is to combine farming system analysis and biosphere analysis with integrative regional modelling techniques.

Keywords: Biodiversity, biosphere analysis, farming system analysis, incentive systems, natural preservation, regional modelling

A Study on Tree Diversity in Association with Variability of Ironwood (*Eusideroxylon zwageri*) in Jambi, Indonesia

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A study on tree diversity in association with variability of ironwood has been conducted at Senami forest stand in Jambi, Indonesia. Senami is one of natural forest stand that dominated by ironwood (*Eusideroxylon zwageri* T. et B.) species. The researches have been conducted from October 2002 to November 2002 using systematic plot sampling. The field research found that ironwood grows associatively with more than a hundred tree species. At tree stage, species that were recorded are 99. At pole stage, ironwood grows associatively with 90 species. At sapling stage, it grows with 125 species while at seedling stage ironwood grows with 92 species. The most important species for wood production are *Eusideroxylon zwageri*, *Palaquium hasseltii*, *Litsea* spp., *Ochanostachys amentacea*, and *Shorea* spp. All of the species belong to 28 families. The most dominant family is *Lauraceae* followed by *Moraceae*, *Euphorbiaceae*, *Anacardiaceae*, *Caesalpinaceae* and *Burseraceae*. The study also revealed that each ironwood variety grows in some small clusters. It can be found in about 68 % of forest area. The alternatives of cluster composition of ironwood variety are daging, kapur and sirap (4.69 %), daging and sirap (9.38 %), and sirap and tanduk (4.69 %). Sirap is the variety that able to form cluster with any other varieties. The SØRENSEN coefficient index between ironwood communities obtained that the most similar communities are the communities between daging and sirap with index of 0.792, followed by daging and kapur (0.569), sirap and tanduk (0.497), kapur and sirap (0.488), daging and tanduk (0.478), and kapur and tanduk (0.364).

Keywords: Ironwood (*Eusideroxylon zwageri*), tree diversity, variability

Status of Under-Utilised Tuber Legumes Yam Bean and Wild Cow Pea in Indonesia

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The yam bean (*Pachyrhizus* spp.) was introduced to South East Asia in 16th century from America. It has received more interest since the Amazonian yam bean Chuin has been found which is used and processed like cassava. The wild cow pea (*Vigna vexillata*) is used in Asia, Africa and Central America for its tuberous roots. The objectives of this study were to record the cultivation status as well as the use and processing knowledge of these species in Indonesia. In a collection trip a questionnaire was used to record these information. 110 yam bean (*P. erosus*) and four cultivated *V. vexillata* accessions were collected. The yam bean — local names: *Bengkuang*, *Uas* or *Bose* — is cultivated on all major Indonesian islands. Cultivated *Vigna vexillata* — local names: *Jempirang* — has been found only in Bali. Personal communications indicated that there is also cultivation in Timor and Papua. The yam bean is known as vegetable crop rather than as root crop. It is consumed raw as salad or as refreshing tuber fruit. The *Jempirang* is considered as a root crop-tubers and is always steamed or boiled before consumed and seeds are additionally used. Yam bean yields are 10 to 70 t ha⁻¹ in West Indonesia (Sumatra and Java) compared to 10 to 50 t ha⁻¹ in East Indonesia (Sulawesi, Timor, Flores and Sumba). In East Indonesia it is predominantly intercropped with maize and cassava due to poor soil conditions. The *Jempirang* yields are 20 to 30 t ha⁻¹. It is cultivated after rice (*Oryza sativa*) in the dry season. In conclusion the *Jempirang* should consider more attention as a legume root crop and merits further investigations e.g. crossings with *V. vexillata* var. *lobatifolia* from the Namibian drylands. Furthermore, the yam bean should be considered as an additional option for intercropping systems. A higher dry matter Amazonian yam bean — so called Chuins — are lending themselves as a protein rich starchy stable as well as incorporation of high dry matter into the South East Asian yam bean gene pool. The differences between these gene pools are currently under investigation.

Keywords: Neglected crops, legume root crops, yam bean, *Pachyrhizus*, wild cowpea, *Vigna vexillata*

Crop Diversity and Its Changes in Rural Homegardens of Central Sulawesi, Indonesia

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Tropical homegardens with their large crop species and varietal diversity are regarded as an ideal production system for *in situ* conservation of plant genetic resources. They are also known to be fields of experimentation and domestication of wild plants. However, garden diversity varies according to ecological and socio-economic factors and/or characteristics of gardens or gardeners. But little is known about these factors and the dynamics of crop diversity. This study aims to assess the stability of homegarden crop diversity over a period of two years as well as the influence of selected factors on the diversity.

In 30 homegardens randomly selected from three villages adjacent to the Lore Lindu National Park in Central Sulawesi, species diversity and abundance were assessed in the years 2001 and 2003. Overall, 149 crop species were identified in 2001 and 168 crop species in 2003. The gardeners stopped growing 16 crop species altogether, while planting 37 new species, chiefly new vegetable and medicinal plant species. Many gardeners cultivated minor crops, thus, playing an important role in conserving such under-utilized crops. Compared with 2001, at present nearly 80 % of the gardeners cultivated more crop species, even minor crops (e.g. two “new” *Solanum* species as leaf and fruit vegetables). Of many crops, several varieties were cultivated, e.g. 25 of banana and 13 of chilli. Homegardens from one village, mainly inhabited by migrants, contrasted strongly with those from the other two villages with mainly indigenous inhabitants. Total number of crop species as well as average number of species per garden, species density and diversity (SHANNON index) were markedly lower in the migrant village. Species composition was clearly different between the migrant village and the other villages investigated. Besides ethnicity, crop diversity could have been influenced in varying extent by additional factors such as soil fertility (that is low in the migrant village), age and size of homegarden or market access.

In conclusion, crop diversity seems to be less static over time but rather dynamic. Nevertheless, the number of crop species has not decreased in the period studied. The sustainability of the homegardens investigated as well as their suitability for *in situ* conservation of plant genetic resources is discussed.

Keywords: Genetic resources, *in situ* conservation, sustainability, Indonesia

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Evaluation of a Worldwide Collection of Safflower for Morphological Diversity and Fatty Acid Composition

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Safflower (*Carthamus tinctorius* L.), a member of the family *Asteraceae*, is a multi-purpose crop for oil, medicinal, and industrial uses. A total of 747 accessions were obtained from different genebanks throughout the world and were grown in 2002 in a replicated field trial in Göttingen, Germany. The overall objective of this research was to evaluate agro-morphological traits (plant height, days to maturity, flower colour, head size, diseases, and spines) as well as fatty acids (palmitic acid, stearic acid, oleic acid, linoleic acid) and to study geographical patterns of diversity. Only the 193 accessions with best seed production were used for the quality analysis. From these, the 169 accessions with known origin were divided into eight geographical regions: East Asia, South Western Asia, Eastern Europe, Central Western Europe, Southern Europe, Mediterranean, Africa, and North America.

Analysis of variance showed significant differences among accessions for all traits analysed. Oleic acid varied from 7.8 % to 29.4 %, linoleic acid from 61.2 % to 83.6 % and palmitic acid from 1.8 % to 12.8 %. The amount of dominant fatty acid (linoleic acid) and days to maturity showed highly significant differences between regions as well as within all eight regions. In addition to the eight geographical groups, a ninth group with 24 accessions whose origins were unknown was included for clustering and principal component analysis (PCA).

Both cluster analysis (CA) and PCA for agro-morphological traits and fatty acids gave comparable results and showed a complex relationship among accessions, characters and geographical origin. However, CA showed no clear grouping of accessions according to their geographical origin. The results displayed large genetic variability among the safflower accessions evaluated, which could be used in future breeding programs and in selecting directly from germplasm collections.

Keywords: Cluster analysis, fatty acid, genetic diversity, geographical origin, *Carthamus tinctorius*, morphological traits, principal component analysis

Species Diversity in Fallow Lands of Southern Cameroon — Implications for Management of Man-Made Landscapes

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In West tropical Africa, concern for more profitable and ecologically sustainable fallow systems provided impetus for initial research, particularly given the reported increasing abundance of fallows of shortened duration. A lack of reliable information regarding the characteristics of these land use systems in the humid forest zone of southern Cameroon has hindered resource managers' attempts to develop adapted strategies. This information can be useful in helping target specific fallow management prototypes to particular areas and types of fallow. A study was initiated in 1998 to assess species diversity as influenced by fallow age and fallow type, and interactions between the invasive fallow species *Chromolaena odorata* (L.) R. M. KING & H. ROBINSON and native plants were investigated. An assortment of biotic variables and abiotic variables was assessed to determine the relative importance of each. In total, about 224 species of vascular plants were recorded from the study sites, belonging to 74 families. The present study revealed that species and functional diversity were significantly associated with vegetation structure and plant community composition in 5–7 years old fallows under different land use intensity regimes. Ordination analyses showed a clear pattern of distribution of species along a gradient of resource use intensity. The separation of species scores along the first two axis of the ordination diagram revealed three main groups of species. Group 1 mainly constituted of weedy species, while Group 2 was mostly made of secondary rapidly growing woody (or semi-woody) pioneer species, and species of Group 3 were mostly plants that are found in the under-storey of secondary forests in the area. *C. odorata* was present in nearly 95 % of the sampled sites, and was commonly associated with *Cnestis ferruginea* DC., *Dichapetalum* sp. and *Haumania danckelmaniana* MILNE-REDH.. Although canopy height was the best predictor of species richness and diversity, litter depth and basal area added significantly to the explained variability. The results of this study indicate that soil physical and chemical properties were significantly correlated with the plant species composition across the three study environments, accounting for up to 30 % of the variation in species distribution.

Keywords: Biodiversity, *Chromolaena odorata*, fallows, land use, species richness

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Legume Diversity and Ethnobotanical Surveys in the Northern Guinea Savannah of Nigeria

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The study aimed at conducting an ethnobotanical assessment of the local recognition of wild and cultivated legumes. The target area was around Zaria, Kaduna State. The area is classified in different resource use domains according to population pressure and market access. Thirteen villages out of four different domains were chosen for the interviews.

Concerning wild legumes, 427 semi-structured interviews with the visual aid of a voucher herbarium consisting out of 55 wild legumes that were collected in the study area were conducted. The interviews were done separately with men and women and with different ethnic groups, mainly Hausa and Fulani. Concerning cultivated legumes, 74 interviews with men with the help of cowpea and bambarra nut seed samples were conducted.

The interviews on wild legumes contained questions concerning the vernacular name, the local classification, plant habitat, species abundance in the area, indicator functions, soil preferences of species, soil fertility attributing characteristics and traditional. The recognition of the herbarium specimens was high and legumes were used by both sexes and ethnic groups in many ways, such as in human medicine, in veterinary medicine, in various technical applications, in supernatural practices, for human consumption and as animal fodder. Gender related activities concerning collection and the use of wild leguminous plants were observed.

The surveys on cowpea (*Vigna unguiculata*) and bambarra groundnut (*Vigna subterranea*) contained questions on cultivar diversity, genetic erosion of local varieties, the production system and seed storage and seed supply system. The legumes were spatially and temporally integrated in the production system. Seed storage and seed exchange was a common practice, whereby the strengthening of the seed supply system was seen as important. The information gathered showed a static genetic erosion of traditional cultivars in all resource use domains due to three different main reasons: individual abandonment, accidental loss and large scale abandonment.

As conclusion, the multipurpose uses of legumes are acknowledged in the study area. There is the potential to integrate legumes further in the existing production system. The conservation of the traditional knowledge concerning wild legumes can be seen as important due to high migration in the study area.

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Keywords: Biodiversity of wild and cultivated legumes, ethnobotany, genetic erosion, RRA, semi-structured interviews, multipurpose uses of legumes, traditional knowledge

Various Drying Technique Affected Papaya Seeds Qualities

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Papaya seeds production always face with a low germination due to post-harvest technique. Moreover, there has not exactly suitable method for seed drying. The drying of seed can have major effects on seed quality. This experiment was determined the proper drying technique in order to get better papayas seed quality. Papaya seed was brought from Samngao District Plantation, Tak province, Thailand. Three drying methods were sun drying, 40°C hot air oven and using silica gel as the moisture absorbent. Initial seed moisture were investigated and recorded. Seed samples were dried until it reached the moisture content of 20, 15, 10 and 5 percent. Standard germination tests, Vigour test by accelerated aging technique, Viability test by Tetrazolium test were used. It was found that drying with silica gel result 57 % germination, 92 % in viability test and 38 % in vigour test. Hot air oven drying provided 47 % in germination, 90 % in viability test and 29 % in vigour test. The result of two previous methods can maintain the papaya seed viability but can not sprout may be due to seed chemical inhibitant. While the sun drying resulted the poorest quality of the seed which were 30 % in germination 85 % in viability and 19 % in seed vigorous. The use of sun drying system has provide high temperature which generally make them unsuitable for small scale drying harvested seed crops. Dehumidifiers using solid desiccants as silica gel can reduce the relative humidity below 40 % and then the seed moisture removed. Therefore, drying with seed moisture absorbent was the best result and sun drying was the poorest method.

Keywords: Accelerated ageing technique, seed vigour, Tetrazolium test

Current Status on Mangosteen Mutation Breeding in Indonesia

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Mangosteen (*Garcinia mangostana*) is a unique tropical fruit that rich with vitamin and mineral. This fruit is originated from South East Asian region, particularly Indonesia, Thailand and Malaysia. As an obligate agamospermy, the seed is developed without fertilisation and chromosome reduction. Therefore the variability of mangosteen is narrow. One possibility to widen genetic variability is using gamma rays irradiation. Germination and initial proceed of mangosteen very slowly. Slow seedling growth is attributed to a weak root system, characterized by the absence of root hair and poor development of laterals. Slow growth of root is one of mangosteen problems. Plant Breeding Lab, Padjadjaran University Bandung, Indonesia has an extensive program to broaden the genetic variability of mangosteen in Indonesia and to select the superior mutant as new variety. Irradiated seed with 1 krad, 2 krad, and 3 krad dossages of gamma rays, had been planted in nursery of College of Agriculture, Padjadjaran University, Bandung. However, irradiated seed with 3 krad emerge very late (15 days later after wild). Above 80 % irradiated seed with 1 krad and 2 krad dosages of gamma rays were able to grow but differ in growth rate, height of plant, size of leave, color of leave, content of chlorophyll, a number of lateral root, root length in 50 days after planting compared to the wild. About 4 % seedling is longer root compare to the wild. Furthermore, molecular analysis using RAPD showed DNA changing on mutant. Two primers, i.e. OPH13 and OPH18 could differentiate between wild and mutant, irradiated seed with 2 krad gamma rays. However, three others primers, i.e. OPH12, SB13 and SB19 could not be used as a differentiate marker since they showed monomorphism. Mutation could be used to broaden genetic variability in order to improve desired mangosteen traits.

Keywords: Indonesia, mangosteen, mutation breeding

Biodiversity of Arthropods and their Movement Patterns in the Upland Landscape of Leyte, Philippines

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In the humid tropics of SE-Asia the last primary forests are dwindling at an alarming rate. In the upland of Leyte island this is due to commercial and illegal logging activities and intensive slash and burn agriculture. The loss of the natural vegetation cover is accompanied by a decrease in diversity of fauna and flora, consequently also in ecosystem services and interactions, thus destabilizing the system and finally leading to degradation.

The study approached two questions: Which structures and components of the cultural landscape are of significance for conserving arthropod biodiversity, and, which of the forest species are able to become resident in the managed system? It was focused on interchanges of insects between the natural and the managed landscape.

Insect and plant communities and the movement patterns of selected insect species were examined along a gradient from the natural forest through the agricultural land. On the cultivated land, the cropping patterns were mapped and weed populations examined. In the forest, occurrence and distribution of trees, ferns, bushes and herbs were considered.

Insects were caught by using modified malaise-traps, which allowed a separate catch for each of the two arrival sides, whereby the one was always opened to the forest and the other to the field. Four traps were used, considering the forest interior, the forest edge and the cropping area. Traps were circulated between three sites for a total of 18 months in 2001 and 2002. Shannon diversity and evenness of the whole catch were calculated for each arrival side of all traps and compared. It was found that arthropod diversity in and also oriented to the forest is higher than in and oriented to the field. Highest values were found at the forest edge. Movement pattern of the selected pest species showed, that the most dangerous pests are monophagous and were probably introduced with their host plants. Movement pattern of selected forest species showed decreasing penetrations into the cultivated land with increasing distance to the forest. Natural forest species which are able to become resident in the diverse agroecosystem could not be found.

Keywords: Tropical agroecosystems, upland farming, arthropods, biodiversity, Philippines

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Salt Tolerance of Paddy Rice (*Oryza sativa*) Varieties from Myanmar

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One of the main rice production constraints in Myanmar, where rice (*Oryza sativa* L.) is the main staple food and cultivated in the coastal and delta area, is the intrusion of sea water, which penetrates in rivers, so that the salinity of irrigation water raises more and more. Apart of appropriate cultivation methods, one possibility to minimize salinity problems is the choice of salt tolerant rice varieties. The objective of this study was to find out the salt tolerance of the six most cultivated paddy rice varieties in Myanmar.

Twenty seeds of each of the rice varieties Shwewatun, Manawthukha, Hmawbi (2), Inmayebaw, Yezin (3) and Shwethweyin were placed in filter paper lined petri dishes. The 4th and 6th are local, the others are high yielding varieties. NaCl treatments of 0, 1.227, 2.629 and 5.550 g l⁻¹ were dissolved in distilled water corresponding to 0 (control), 2, 4 and 8 dSm⁻¹. The petri dishes were arranged in a complete randomized block design in a climatic chamber at 25 °C with 12 h daylight. The number of germinated seeds was counted after 5 days. A seed was considered to have germinated when both plumule and radicle had emerged 0.5 cm. Seedling shoot dry weight and root dry weight were taken after 10 days. Total germination was expressed as a percentage of that in the control treatment for each variety.

Germination, shoot dry weight and root dry weight were significantly influenced by salt levels, varieties and the interaction of both. All three criteria were reduced by increasing salt levels. The average salinity threshold was 3.5 dSm⁻¹, but differed for the varieties and for the three tested criteria. Root dry weight was more influenced than germination, and germination more than shoot dry weight. The most tolerant variety was the local variety Shwethweyin, while the most sensitive was the high yielding variety Hmawbi (2), the other four varieties showed medium salt tolerance. The ranking list from salt tolerant to salt sensitive was: Shwethweyin — Shwewatun — Yezin (3) — Inmayebaw — Manawthukha — Hmawbi (2).

Keywords: Rice, salt tolerance

Prediction of Soybean Seed Viability and Quality in Relation to Seed Moisture Content and Storage Temperature

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This experiment was designed to predict viability and quality changes of stored soybean seeds (*Glycine Max* (L.) MERILL) of the cultivar CM60 which stored at various conditions. The treatment was; four seed moisture contents 6, 8, 10 and 12 percent and five storage temperatures of 15, 20, 25, 30° Celsius and room temperature. Seeds were stored for 120 days and seed quality assessment was done every 2 weeks. Standard germination test, electrical conductivity test, seedling growth rate, viability test by tetrazolium test and vigor test by accelerate aging technique were determined and investigated. After 8 weeks storage, the percent of germination in all moisture level still remained above 70 percent and storage temperature at 15° Celsius rate of germination decreased. Moreover, electrical conductivity values of all conditions were increased more than 100 micromole/g seed, but seedling growth rate decreased after storage. Viability test by tetrazolium technique was higher than 80 % in all moisture content levels excepted at 12 percent where the value is lower than 75 %. The relative ease which the conductivity test can be done as vigor testing, the quantity of solute leaked showing a negative correlation with viability in seed sample. In addition, seed moisture content at 6 and 8 percent tested vigour by accelerated aging technique, showed only 70 percent of germination. The storage, at high seed moisture content and in high temperature affected seed vigor that decreased continually . Thus, this experiment provided the results on quality of seed, which showed relation between seed moisture content and storage temperature. They are possible to be used to predict viability and quality of soybean seeds storability.

Keywords: Prediction, seed vigour test, viability test, storage

***Thaumatococcus daniellii* — A Natural Sweetener from the Rain Forest Zone in West Africa with Potential for Income Generation in Small-Scale Farming**

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The sweet prayers plant (*Thaumatococcus daniellii*) BENN. BENTH. is widely found in tropical rain forests of West Africa. Local uses are versatile, ranging from cultivation as fetish plant in Gabon to collecting leaves from its natural habitat for wrapping and boiling food in Ghana and Nigeria. The most exiting use of *T. daniellii*, however, is its use as sweetener or taste modifier. The aril of the fruit contains thaumatins, a mixture of extremely sweet proteins. For that reason, *T. daniellii* is traditionally used for sweetening bread and flavouring palm wine. Since the mid-90s, it is used as sweetener and flavour enhancer by the food and confectionary industry in many countries, substituting synthetic sweeteners. Presently, fruits are extracted from the natural habitat and sold to buying companies. The way how the fruits are collected, is often not sustainable. Furthermore, fruit damage leads to irregular supply which is not attractive for the food industry. Integrating *T. daniellii* in cropping systems or plantations seems to be a promising way to lessen these shortcomings, contributing to both income generation and diversification of crop production by small farmers. Knowledge on cultivation of *T. daniellii*, however, is not available. This study aimed at collecting basic information on current uses, botany, ecological requirements of *T. daniellii* and its potential for future cultivation. Therefore, interviews with key informants and a field trial were carried out in the Western Region of Ghana in 2002. The evaluation of the questionnaires improved the understanding of production conditions and contributed to identify possible production and adaptation constraints. The field experiment produced information on light requirements of *T. daniellii* for field establishment and growth during early growth stages.

Keywords: Biodiversity, Ghana, income generation, new crops, plant genetic resources, rain forest zone, sweet prayers plant

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Agronomic Evaluation of the Cultivated Yam Bean (*Pachyrhizus* spp.) Germplasm under West African Conditions

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The yam bean is a legume root crop usually known as a vegetable crop. Three cultivated species are distinguished: Amazonian yam bean (*Pachyrhizus tuberosus*), Mexican yam bean (*P. erosus*) and Andean yam bean (*P. ahipa*), but interspecific hybrids are fertile and vigorous. The crop might have the potential to be used like soybean and cassava. The 1000-seed weight is high (from 180 to 230 g), seeds have a high protein (26 to 32 %) and oil (22 to 26 %) content with about 20 % carbohydrates of seed weight. However, for consumption the compound rotenone (about 1 % seed weight) has to be extracted or destroyed. Tubers are characterized by high moisture content (usually about 80 % of fresh tuber weight), but Chuin types of *P. tuberosus* have a low moisture content (about 70 %) and are used like cassava. The tuber includes starch as the main component and has a high protein content (8 to 18 % of dry matter). Agronomical data for the yam bean is limited. 34 accession were grown in Benin at two locations - one under drought stress conditions - with and without pruning of reproductive parts. The average tuber yield over both locations ranged from 6 to 45 t ha⁻¹, 21 to 81 t ha⁻¹ and 10 to 38 t ha⁻¹ for the Amazonian, Mexican and Andean yam bean, respectively. In a combined utilization of tubers and seeds tuber yield ranged from 5 to 29 t ha⁻¹, 10 to 49 t ha⁻¹, 6 to 27 t ha⁻¹ and seed yield from 1.5 to 2.9 t ha⁻¹, 3.5 to 4.6 t ha⁻¹ and 2.6 to 2.7 t ha⁻¹ for the Amazonian, Mexican and Andean yam bean, respectively. The tuber dry matter content ranged from 18 % to 36 % of fresh tuber weight with 8 to 14 % raw protein content on dry matter basis. From all species tubers were processed to 'gari' after traditional starch extraction. Moreover, accessions could be made available by CIP Lima/Peru and can be freely distributed from country to country. In conclusion attractive yam beans could be identified for West Africa.

Keywords: 'Gari' processing, agronomical evaluation, Amazonian yam bean, Andean yam bean, legume root crops, Mexican yam bean, neglected crops, *Pachyrhizus*

Distribution of New Enset Landraces (*Ensete ventricosum*) in Ethiopia

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Enset (*Ensete ventricosum*), a Musaceae, is cultivated in southern and southwestern Ethiopia for its starch containing leaf sheaths and corm. It shows a broad diversity in landraces. Farmer claim the need to grow a number of landraces due to their manifold properties for human consumption, animal feed, agriculture, household, construction and traditional medicinal treatments. Usually enset is propagated vegetatively to preserve the characteristics of the landraces. Farmer try to improve their enset plantation by introducing new landraces.

Farmer in ten enset cultivation regions were visited in 1994 and 1998–1999. They were interviewed about the landraces they grow and the plants' uses. Possible ways to obtain new landraces, selection criteria to introduce new landraces, and regional differences were studied and compared with literature on the same localities. Distribution of landraces from their original growing areas to other regions became important after the drought in 1984/85 when plantations were almost exhausted, and farmer had to buy plants from distant regions. New landraces are supplied either by trade, by exchange with neighbours or distant relatives, by collecting uncultivated species, or by spontaneous mutation or seedlings. Selection criteria are adaptation to climate and palatability. Regional differences are evident regarding exchange of enset and use of seedlings and mutants.

Comparison with older studies at the same localities often showed partly different names for landraces. Investigations in 1994 and 1998–1999 showed different frequencies of certain landraces. Changes are due to preferences of the farmer and improved infrastructure, but possibly also due to climatic changes. This might explain the introduction of highly frost susceptible but favoured landraces to high altitudes, while bitter tasting landraces with a high tolerance to frost diminish. Classification of genotypes is an option to identify landraces, their migration and genetically determined site requirements and properties, and offers the chance to optimize enset cultivation at any particular site.

Keywords: Distribution of landraces, *Ensete ventricosum*, exchange of plant material, seedlings, vegetative propagation, Ethiopia

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Participatory Plant Breeding — Institutional Innovation and Technological Change

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Farmer participation in plant breeding covers the whole spectrum of activities aiming at genetic improvement of crops, from setting priorities for a selection program, to generating new variability, identifying, evaluating and distributing new varieties, as well as the wide range of institutional options for farmer–scientist collaboration. Similarly the reasons for farmers and scientists to work together cover a wide range of goals and ambitions.

Over the past ten years experiences with farmer participation in plant breeding efforts have increased in overall numbers, have advanced in methodology for conducting trials and evaluating new materials, and have started to explore issues of scale. To illustrate key consequences from these changes in the running of breeding programs three types of examples shall be presented. The first set of examples covers methodological changes in the evaluation of finished varieties that lead to the identification of varieties preferred by specific farmers, to multiple releases, and can be the stepping stone for decentralized seed distribution systems. A second set of examples concerns the assessment of farmers' seed management practices that reveal particular strengths and weaknesses for building a coherent program of collaboration, and harnessing benefits on a larger scale. The third set of examples addresses cases in which farmers seek technical assistance from breeders to advance the development of their own varieties. Conclusions from this overview cover issues of participation and scale, breeding strategies and selection criteria, linkages between variety development and seed distribution, quantifying benefits and impact monitoring.

Keywords: Farmers' participation in plant breeding, institutional innovation, plant breeding

Adoption Potential for Fire-Free Agricultural Practices by Smallholders in the Eastern Amazon of Brazil

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In the Eastern Amazon Region of Brazil the shortening of natural fallow periods constitutes major challenge in preserving secondary forests that are considered an important resource for human livelihoods. In response to this challenge, fire-free agricultural practices (the combination of mulch technologies and fallow improvement techniques) have been developed as promising agricultural production technologies that may contribute to the conservation of soil quality and secondary vegetation. Awareness of the adoption potential of such technologies would help to design appropriate extension approaches and policy interventions to support smallholders. In this paper, a case study of 270 farmers in the Bragantina Region was carried out to investigate which factors affect the willingness of smallholders to adopt mulch technologies using a tractor driven bush-chopper. The analysis confirmed that income, farm size, knowledge of fire-free agricultural practices, soil quality, and fertilizer use are factors associated with the potential acceptance of the technologies.

Keywords: Adoption potential, contingent valuation, fire-free agricultural practices, Brazil

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Path Dependence and Adoption of Sustainable Agricultural Technologies — Case of Cotton-Producing Region of West Africa

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Most of the studies to determine the factors influencing farmers' adoption decision-making are based primarily on the analysis of contemporary factors and currently observable situations of farmers. Few studies exist to evaluate how historical antecedents and events have affected farmers' contemporary adoption decisions. This paper identifies "path dependence" as an important concept that provides historical insights into contemporary patterns of adoption behavior of farmers regarding agricultural technologies in general and sustainable agricultural technologies in particular. The objectives of the paper are two-folds. First, it discusses the concept of path dependence and demonstrating how antecedent events of policies and institutional arrangements exert strong influences on the contemporary adoption decisions of farmers regarding a given technology, and create structural impacts that tilt farmers' contemporary adoption decision in favor of a particular technology against the others, sometimes irrespective of the characteristics of the various technologies. Second, it presents an empirical case study of the adoption of two crop protection technologies — a sustainable and more ecologically friendly integrated Pest Management (IPM) and chemical based pesticide technologies — in a major cotton production region of West Africa (Ivory Coast) to illustrate how an interplay of various agro-economic and institutional policies of the government combined to create structural shifts over time in the adoption decisions of the cotton farming community in favor of pesticides against IPM. The paper concludes that farmers may not adopt certain technologies appreciably, not necessarily because the technologies are inappropriate, but simply because the enabling economic policies and institutions are not right. The paper recommends that studies to determine why farmers do not adopt some technologies but adopt others should not focus exclusively on contemporary factors, but should also require an understanding of both the historical and contemporary institutional arrangements and policies favoring or biased against the technology and its competing options.

Keywords: Adoption, cotton, crop protection, Côte d'Ivoire, IPM, path dependence, pesticide

Selection and Strategic Use of Multipurpose Forage Germplasm by Smallholders in Production Systems in the Central American Hillside

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Smallholders in the hillsides of Central America have to adapt to prolonged dry seasons and changing global market conditions while struggling with soil fertility losses and the reduction of arable land due to population growth. Traditional maize-bean systems are no longer providing sufficient returns to cover production costs and grant adequate living conditions. System diversification and intensification are needed. Multipurpose forage plants have the potential to play a decisive role in this process by enabling the integration of livestock and crops in farming systems. While offering feed, multipurpose forage plants are also key elements for soil conservation and soil fertility enhancement. Moreover, dry season tolerant forage plants may lead to an more even cash flow throughout the year. Multipurpose germplasm has to combine characteristics for variable demands, germplasm selection, development and subsequent dissemination has to be carried out in a participatory framework. During the last three years, such a participatory framework was used for the selection and strategic use of multipurpose forage germplasm in the hillsides of Honduras, Nicaragua and Costa Rica offering farmers an ample collection of grasses, herbaceous legumes, shrubs and cover crops. Participatory evaluations of forage options through farmer groups supported by on-farm experiments resulted in a diversity of selected germplasm and its dissemination. A method for quantitative and qualitative analysis of data from participatory evaluations was developed which also enables researchers to match farmer information with formal agronomic evaluation data creating germplasm profiles for different uses and environmental conditions. This information is highly valuable to define further research needs and for germplasm targeting purposes. A GIS based germplasm targeting software tool is currently developed. Results from the BMZ/GTZ funded work motivated development projects in Nicaragua and Honduras to apply the participatory framework approach with new multipurpose forage germplasm. Further steps include the formation of artisanal seed production enterprises in order to maintain the dissemination process and connect farmers to markets. Other forage products such as leaf meal are seen as further market options.

Keywords: Dry season, germplasm targeting, grasses, legumes, participatory procedures, seed production, soil conservation

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Rural Non-Farm Technological Change — Implications for Rural Linkages in Southeastern Nigeria

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Technological change has affected most of rural non-farm enterprises with many positive and negative social and economic consequences. This study investigated the extent of this change and the linkage implications of the change on the rural economy of southeastern Nigeria. It also attempted assessing technical change in relation to the perceived negative consequences, to find out if the change was neutral and/or biased to those consequences.

A total of 200 non-farm entrepreneurs randomly selected from 10 rural communities in 5 out of 9 States of southeastern Nigeria provided the quantitative data. Quantitative and qualitative data were collected using interview schedules and focus group discussion guide respectively. Analysis of qualitative data was by the use of descriptive statistics, cross tabulations and factor analysis. Analysis of qualitative data was by folk interpretation and verbatim quoting of discussants views. Analysis showed that some personal socio-economic attributes of the rural entrepreneurs affected their technological adoption and use behaviour, which were regarded as negative consequences rather than wrong use of technology. Varimax rotated factor matrix of non-farm variables were used to identify and name factors that need urgent technology policy intervention. These include cost of new technology, wrong adoption of technology, non awareness of new technological packages, perception of traditional technology as superior to improved technology among others. Some of the effects of technological change were adjudged neutral while some were taken as biased to the problems of the rural enterprises. Three types of rural linkages identified in the area were: consumption, backward and forward production linkages, and their implications on technological change and the rural economy were highlighted.

Keywords: non-farm entrepreneurs, technological change, Nigeria

Agro-Ecological Zones, Diversity on Farm Systems Level and Technological Changes — The Case of Northern Malawi

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The presented study postulates that farm households achieve an optimal diversity in order to address the needs of subsistence, income and security depending on the agro-ecological environments. Technological changes by either introducing new technologies or changes in the production line do not have significant effects on the agricultural diversity on farm system's level.

In the presented study 200 semi-randomly selected households were interviewed about their activities in order to measure the diversity of the activities per household in four agro-ecological zones in Northern Malawi. The total number of the activities among all households in each sample area defines the universe for each agro-ecological zone. The total number of activities in each household divided by the activities in the particular universe measures the diversity of the activities within the special farm household. The total number of activities does not increase from the arid to the humid sample areas. Comparing the total number of activities in the sample areas, it is found that the maximum number of activities is measured in the semi-humid and semi-arid sample areas while the arid and humid areas show less but similar numbers of activities. The diversity is similar among all particular universes. The introduction of new technologies does not have any significant effect on the diversity.

Opposite to biodiversity, agricultural diversity is higher in tropical zones where climatic conditions are more moderate and allow more flexibility to the rural households. The rural household achieves an optimum in the number of activities carried out. The diversifying effects of introducing a new technology are limited. Changes in the production line do not have any effect on the agricultural diversity.

Keywords: Agricultural diversity, agroecological zones, Malawi, small-scale farm

Sustainable Transfer of Adapted Production Know How — Example of a Small-Size License Production Project for Reversible Ploughs in India

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The intention to produce locally adapted but better performing soil tillage equipment with a local Indian specialist was the target of the LEMKEN GmbH & Co. KG, Germany's leading producer of soil tillage equipment. The project was in first instance a non-profit project but contains elements for a long-term benefit of both partners. India was chosen to start such a project as the country is known to be the world's largest tractor market. All the international tractor companies have license operations in place but yet no implements are available to follow the need for more sophisticated farm machinery.

Steps towards the realisation of the project were:

1. Identification of the right partner: Deccan Farm Equipment pvt. Ltd. in Kolhapur, State of Maharashtra.
2. Determination of the cooperation and road-map to realisation: License production with the founding of a Joint Venture company.
3. Identification of the right product: Reversible plough with different options
4. Steps to know how transfer: Meetings, staff exchange, senior expert program.
5. Branding and marketing of the product in India.
6. International export activities and cooperations.

Latest steps were the launching of the series production in November 2002 and the representation of the product on the international SIMA exhibition in Paris in February 2003. The main problems the project has met so far were the long-lasting and time-consuming know-how transfer, especially on the treatment and handling of the steel, the quality level of production, the communication difficulties and adoptions to black cotton soils and sugarcane cultivation which are common in the project area.

Continuous monitoring and improvements of the production quality and international export trading activities beneath the sales and marketing progress in India are the main topics for the near future. This shall become a base for a successful and long-term cooperation between two independent companies and become a model for a medium-size German producer to respond to the requirements of globalization.

Keywords: India, joint venture, know how transfer, license production, reversible plough

Sericulture — Innovative Technology and Adapted Institutions for Income Generation Among Small Farmers in Indonesia and East Timor

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Sericulture, the production and processing of natural silk from silkworms feeding on mulberry leaves has its origin in China, but has spread to many other regions. Neither land nor labour are in direct competition with the cultivation of staple crops. Sericulture is therefore seen as a potential source of additional income for small farmers in the tropics. The production technology, however, is sensitive and the demands on the organisational and institutional environment are considerable.

Attempts at developing sericulture in the Indonesian Archipelago date back to the 18th century. In the 20th century cocoon production reached its highest level between 1962 and 1966, but collapsed in the 1970's due to the spread of the pebrine disease. From the 1990's rising cocoon prices lead to a production increase. Development efforts were now concentrated on smallholder areas. A first organisational structure was created in Central Java (Banyumas Sutera Alam/BSA) in 1997, under whose umbrella over 200 hectares in five surrounding Mayoralties were planted to mulberry. A first 3-day live-in training program was attended by 700 farmers. In 1999 sericulture was initiated in the Triloka village of the Baucau region, East Timor. A pilot project was commenced with two hectares of mulberry, which has now expanded to 15 hectares with a total of 30 farmers participating in training programs. As in Java initial positive response could not be sustained without additional efforts. Problems were identified on the farm and on the project level, and could partly be rectified. A more in-depth research and monitoring program was instituted on both projects concerning performance in production and institutional organisation. Data were collected from 40 harvest operations (1999–2002) of 150 farmers in the Indonesian and 12 harvest operations of 30 farmers in the East Timor. Investment analyses for different farm size categories were carried out. The institutional performance was subjected to a SWOT-Analysis.

Emerging conclusions are presented with a view to their future application to the two projects as well as to their generalisability for the introduction of innovative technology within new institutional frameworks.

Keywords: East Timor, Indonesia, innovative technology, sericulture, small farmers

Pastoral Innovations and Participatory Development

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For decades, studies have shown that conventional livestock research and development have had little impact in rangelands in “developing” countries. The western model of range management could not be simply transferred to most other parts of the world, and particularly not to Africa. The 1980s marked the beginning of Livestock Systems Research and Development in real-life situations, also in the rangelands. This brought important insights into resource husbandry by livestock keepers, into the multi-functionality of livestock and range resources and into the opportunity costs of proposed solutions. Ecological theory was re-visited in the debate on carrying capacity and non-equilibrium environments, and the opportunism of pastoralists and the complementarity of resource use came to be seen in a new light.

In the 1990s, increasing attention was given to using participatory approaches in project planning, research and technology development, particularly in arable farming systems. Experience has shown that these approaches need some rethinking for application in rangeland situations, where there are narrow limits to technical innovation to increase production, resource rights are more complex than in crop production, and numerous issues of great importance for deriving livelihoods from range resources — such as terms of trade or national land rights legislation — are beyond the control of pastoralists and beyond the realm of local-level participatory research and development. In the rangelands, participatory research and development is much more complex than in arable farming systems, because multiple users of primarily common resources need to be involved. Innovation in socio-organisational and institutional spheres is often more important than hard technical innovations such as new animal breeds or plant species/cultivars or changes in pasture agronomy.

The paper presents some examples of indigenous innovation in the rangelands and some cases of participatory innovation development (PID). It also highlights some of the limitations to PID in the rangelands. It advocates the recognition of indigenous innovations as entry points to PID and outlines conditions for creating a favourable environment for PID in the rangelands.

Keywords: Innovation development, participation, pastoralism, rangeland, Africa

The Effect of Natural Resource Management Projects on Farm Income — Evidence from Peasant Farmers in Central America

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Central American countries have witnessed a severe deterioration of their natural resources. This problem, stemming from poor management, manifests itself in many ways, including losses in productivity and reductions in farm income. Moreover, this deterioration puts at risk the sustainability of economic growth and development in the region, given that Central American economies are highly dependent on natural resources. In order to address this problem, several international development agencies have been financing natural resource management projects in Central America. In general, these projects have endeavoured to reduce the deterioration of renewable natural resources in watersheds while improving the socioeconomic conditions of the low-income rural population of the affected areas.

Although these projects can play a significant role on the development of rural economies, studies that evaluate their impacts are rare. This paper intends to contribute by providing an empirical analysis of four different natural resource management projects funded by the Inter-American Development Bank in Central America. In doing so, a farm income model is developed in which the impact of the projects is captured by their role in motivating the farmer to adopt new technologies and to diversify production.

Household level data for 764 producers randomly selected, collected between November 2000 and August 2001, are used in the econometric analysis. The main results of the study indicate that the technologies proposed by the projects have, in general, positive and significant effect on agricultural income. In addition, farm diversification is found to have a positive and significant effect on farm income. These findings are important in analyzing the sustainability of environmental projects in Central America, because some technologies can be extremely efficient in decreasing environmental risk, but their adoption could be very limited if they do not bring economic tangible benefits to the farmers.

Keywords: Central America, crop diversification, farm income, natural resources, technology adoption

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Categorising Farm Households for Policy Research

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Policymakers rely on researchers to predict the effects of policy-induced price/technology changes on product mix, production technology and ultimately on human welfare in rural areas. While all households are in some ways different, groups of households may make similar resource use decisions and may respond similarly to policy changes. Identifying such groups can be useful for targeting policy action, identifying important groups for predictive modelling, facilitating that modelling process and for cross-site comparisons. This poster suggests one way of categorising farm households into homogeneous sub-groups. Farm households were classified using a Principal Component Analysis combined with a Cluster Analysis using a new data set from the *Zona Bragantina* in the Eastern Brazilian Amazon. Emerging farm categories served as a sampling framework for collecting technical coefficients and other model parameters relevant for selected groups. Results suggest that this combination of multivariate techniques improves cluster interpretation by reducing the number of variables used to establish clusters. The inclusion of regional dummies in cluster analysis is controversial, but it can produce meaningful results if dummy variables contain information that is exogenous to farm households. The usefulness of identified farm household categories for research comparing land use and deforestation patterns in the eastern and western Brazilian Amazon is explored in the final section.

Keywords: Adoption, risk, rural development

Economic and Social Issues Affecting the Sustainability of Cassava Post Harvest Projects in Southern Nigeria

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Over a decade ago, some projects for the processing of cassava (*Manihot esculenta* CRANZ) tubers were established in various villages in Nigeria. The objectives of those projects were to reduce post harvest losses, reduce labour use, reduce shortage of the product and its processed form and raise output and farm-household income.

Cassava is the most important crop in the farming systems of Southern Nigeria as a food crop and cash income source. It is processed into several forms the most common being 'gari' (Cassava flakes). Some of its by-products can be used as starch while the bark is fed to livestock. Its production has expanded tremendously in the past decade, but post harvest problems constrain development.

This paper examines some of such projects established by the International Institute of tropical agriculture (IITA) and another established jointly by the International Labour Organisation (ILO), United Nations development Projects (UNDP) and the National Directorate of Employment (NDE). These were in the form of village processing centres with community participation. It was envisaged that there would be further expansion of these by the communities concerned.

Information obtained is related against a benchmark of a previous study conducted in 1992. Findings show that IITA project has collapsed while that of the ILO/UNDP/NDE is still functioning. Further findings also revealed that such projects were perceived by the community members to belong to a particular 'family' or persons.

Factors leading to this can be located in the relative economic performance, method of introduction of the project, institutional support, ownership structure and community participation. These hold important lessons for policy and sustainable project development and management.

Keywords: Economic, post harvest projects, social issues, Nigeria

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Procedures for Participatory Research with Multipurpose Forages in Central American Hillsides

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Many regions in developing countries are characterised by deteriorating biophysical conditions such as erosion, loss of soil fertility and deforestation, resulting in diminishing resources and decreasing yields. Multipurpose forage based technologies can play an important role in improving the environmental and socio-economic sustainability of smallholder production systems, for instance by improving soil fertility through nitrogen fixation, increasing animal production through improved feed, and controlling weeds. Species that are widely adapted, productive and palatable have been identified, but farmer adoption has been low. One explanation for low adoption rates is that too much emphasis has been placed on supply-driven research with little participation of farmers. With the involvement of national research institutes and non-governmental organisations as well as the University of Hohenheim, CIAT implemented a BMZ/GTZ supported project on participatory research on selection and strategic use of multipurpose forage germplasm in Central American hillsides. Within the framework of this project, research procedures were developed for identifying, testing and evaluating multipurpose forage based technologies with farmers. In the department of Yoro, central Honduras, farmers in 12 communities conducted experiments with different types of multipurpose forages like grasses, leguminous cover crops and shrubs in three different agro-ecological zones during a period of 18 months. The experimenting farmers were differentiated according to their farming systems and resource endowment such as cattle ownership. The research procedure consisted of farming system analysis, problem identification and prioritisation, formulation of research objectives, implementation and evaluation of experiments, which were carried out using participatory methods and based on farmers' demand. Farmers' decision-making, learning, and experimenting were central to the research. Methodological insight into the applicability of participatory methods for research with multipurpose forage based technologies was obtained. Furthermore, a range of suitable forages for small farmers, especially for those living at high altitudes, were identified. Results indicate that different interest groups require different approaches in order to enhance adoption of multipurpose forage based technologies.

Keywords: Central America, farmer participatory research, hillsides, multipurpose forages

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Adoption and Profitability of Agroforestry-Based Soil Fertility Management Technologies

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In southern Africa, the poor soil fertility status and shortening natural fallow period constitute major challenge in meeting the food needs of the people. In response to this challenge, improved fallow was developed as a sustainable option. Farmers have been testing the technology and a number of empirical studies have been undertaken over the years to identify the factors influencing farmers' decision to adopt the technology. This paper presents the financial analysis of AF-based soil fertility technologies with conventional practices of continuous farming with and without inorganic fertilizer. It also synthesis the results of adoption studies and highlights generic issues on the adoption of improved fallows. Financial analysis of the technologies in the South Africa region shows that AF technologies give higher financial returns than continuous (maize) production without fertilizer. The synthesis indicates that farmers' adoption decision is not influenced by technological characteristics exclusively, but by a matrix of several hierarchies of different factors including household characteristics, community level factors, socio-economic constraints and incentives that farmers face, access to information, local institutional arrangements and macro policies on agriculture. Adoption of AF-based technologies is not strictly a binary choice problem but a continuous process in which farmers occupy a position along a continuum in the adoption path. Further, adoption of improved fallows may not take place in a policy vacuum but needs to be facilitated by appropriate and conducive policy and institutional framework. The paper concludes by identifying emerging issues and questions for further analysis in the efforts to improve our understanding of the processes underlying the adoption of sustainable soil fertility technologies.

Keywords: Adoption, natural resource management, soil fertility, Southern Africa, sustainable agriculture

Econometric Analysis of Socio-Economic Factors Influencing Investment into Agrochemical in Cameroon — A Survey in Peri-urban and Urban Agriculture

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The agricultural sector is the most important in African economies employing as much as 50 % to 80 % of the labour force. However, importation of food is still needed to curb the increasing gap between food demand and food production. As shown by several studies, one of the most critical problems in Africa today is how to increase agricultural production to meet increasing food demand arising from increase in population pressure.

The use of agrochemicals has been the main option for increasing agricultural production in Africa. Fertilizers and pesticides are widely used by farmers in the forest zone of Cameroon, particularly in urban and peri-urban areas where the population density and market access fuel the food demand. This paper quantifies using limited dependent variable regression, the impact of socio-economic factors on investment into agrochemicals, based on a survey of 414 individual inland valley farmers in the forest margins of Cameroon.

The analysis showed that men, the distance to the cultivated plot, the area cultivated, smaller households, are the main factors influencing farmers investment in fertilizers. Urban farmers having full rights to the land cultivated are not keen to use fertilizers. In pesticides, it has been demonstrated that women invest less than men, and contact with extension is a key factor for acceptance. Elasticities calculated showed the effects of policy changes on farmers' investment behavior. The level of education, access to extension services and gender of the farmer influence the probability to invest and the amount invested in agrochemicals in Cameroon.

Finally, results of the study have significant implications for agrochemicals diffusion policy, in particularly how to better target integrated soil fertility and pest management methods which are needed to substitute for the non-sustainable use of chemical inputs.

Keywords: Socio-economics factors, chemical input, Tobit model, urban and peri-urban agriculture, Cameroon

Socio-economic Evaluation of Manure Exchange Contracts — Impact on Farm Productivity in North Western Nigeria

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Following the withdraw of fertilizer subsidies in the mid 1980s by the Nigerian government, a majority of the resource poor rural farmers have found the prices of various brands of fertilizers unaffordable. Efforts have been made by these farmers to look inward to the development of local alternatives as means of maintaining the fertility of their soils. Prominent among such local innovations are the use of livestock manure. These manures are normally obtained through manure contract based on an exchange between croppers and herders and from farmers own livestock. These interactions between crop and livestock is beginning to receive increase attention and is popularly referred to as crop-livestock integration. This paper describes crop-livestock integration, manure contract exchanges, and it quantitatively determines the factors that facilitate this exchange. It studies the impact of manure contract exchange on crops yields and productivity of farmers in the study area of north western Nigeria. Finally, the problems that militate against manure exchange contracting and question on how they could be remedied to enhance effective contracting are examined. A nine months field survey was carried out in Zamfara reserve in Nigeria from December 2001 and August 2002. Information were collected from farmers using household level approach on socio-demographic characteristics, resource endowment, production activities, production inputs and outputs. Manure acquisition from owned livestock and through manure contract exchange and the reasons for participation in manure contract exchange were investigated. Other methods of soil fertility maintenance were also examined. Econometrics models are used to determine factors driving participation of farmers in manure contract exchange as well as impact of manure on crop productivity. First results shows that there are social and economic factors driving the adoption of manure contract and determine exchange participation by farmers. Sub-studies also shows that participation in manure contract have positive impact on sustainable crop productivity and food security in the study area.

Keywords: Manure exchange, crop-livestock integration, crop productivity, croppers and herders, Nigeria

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The Effect of Technological Improvement in Farming and Household Conditions on Agricultural Land Use in Ghana, 1984 – 2000

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In the face of increase in technological capacity in farming systems, practices, implements and tools used, population growth as well as general improvement in household living conditions and affluence within the period 1984 and 2000, there has been a transformation in the utilisation of agricultural land in two agro-ecological zones (dry savannah and derived savannah farming communities) of the Volta river basin of Ghana. This study uses evidence of a longitudinal household survey carried out in 2000 in the two communities, to assess the role the issues mentioned above have played in influencing agricultural land use both spatially and temporally. A multiple regression model has been adopted to ascertain the significant shifts in the predictors of agricultural land use between 1984 and 2000. The dependent variable has been measured by total household cropped area, and the independent variables include, farming tools, practices and implements used (tractor, inorganic fertiliser, improved seed variety use, length of fallow and land tenure arrangements), improvement in general well-being of household members (educational attainment of household members, size of household), population and affluence (off-farm and on-farm income as well as ownership of certain household items such as car, motorcycle, bicycle, television and radio and livestock namely, cattle, sheep and goat). The results of the multiple regression analysis show that while the use of technologically advanced forms of farm inputs such as tractor, inorganic fertiliser and improved seed variety were not significant predictors of agricultural land use in both communities in 1984, the situation changed in 2000, due to the fact that improved seed variety became a significant variables. Furthermore, the length of fallow period allowed influenced agricultural land use in both communities in 1984 but not in 2000 an indication that fallow periods have shortened. Finally, variables like off-farm income and population growth, have played significant roles in agricultural land utilisation in 2000.

Keywords: Technological improvement, household conditions, agricultural land use, river basins, Ghana

Disease Infestation in Tomato Production in Taiwan and Farmer's Willingness to Pay for Control Measures

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Tomato production in subtropical and tropical climates with high rainfall is severely constrained by a variety of bacterial, fungal and virus diseases. A recent survey among tomato producers in Taiwan found that Bacterial Wilt may account for as much as 100 % loss in total production, and Tomato Leaf Curl Virus (TLCV) may account for as much as 75 % of loss in marketable crop. On average, per cropping cycle, Bacterial Wilt and Virus diseases account for 25–30 % and for 10–12 % of crop loss, respectively. These findings explain why disease pressure is the major tomato production constraint for 40 % of the farmers.

Recent advances in disease research highlight the potential both for improved tomato varieties and cultural practices. This study, covering two different sites in Taiwan, analyzes farmer's willingness to pay for different disease management practices in tomato production. The survey shows that farmers are more interested in cultivating tomato varieties that are resistant to TLCV and bacterial wilt, than in applying other measures such as soil amendment practices and grafting on resistant rootstock. On average farmers are willing to pay an additional 50 % on current seed cost, if the cultivars they grow have the traits of disease resistance and fruits are acceptable to the market. Factors that are predictive of a high or low willingness to pay are farmer's age, education, income and total farm size. Approximately 40 % of farmers would also be willing to use transgenic varieties. Overall, the results show that breeding for disease resistance continues to be an important task for international agricultural research centers.

Keywords: Disease resistance, Taiwan, tomato, willingness-to-pay

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Access to Knowledge — A Prerequisite to Sustainable Development

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In September 2000, the international donor community agreed upon the so-called millennium development goals as the main development cooperation agenda. In April 2001, the German government issued a respective Plan of Action 2015. In 2002, the World Bank published a fundamental study on the relevance of higher education as an important contributor to sustainable development. However, there is a preoccupying imbalance between theory and practice. Development issues are still to a large part missing in higher education curricula. The implementation of functioning systems in basic education, public health, or environmental protection is scheduled to fail if the higher education sector in the developing countries is not actively involved in planning development programs that are appropriate to their countries. Sophisticated development models such as sector wide approaches (SWAPs), poverty reduction strategy papers (PRSP), fast track initiatives (FTI) are still to a large extent donor country based enterprises. In order to assure that such models will benefit the people in the target countries, they must be implanted into the local higher education systems where knowledge and its various applications should be enriched with local content. Intellectual ownership is required in order to enable societies to apply and further develop knowledge in a way that relates to their specific needs, traditions and cultures.

Consequently, a number of questions arise that call for appropriate answers, for instance — How to develop responsible partnerships between the international donor community and higher education institutions in the target countries? How can higher education institutions contribute to an effective use of development cooperation inputs? How can the gap between the uneducated people and the intellectual elites be reduced? What kinds of approaches are needed in order to enhance the quality and relevance of higher education to sustainable development? How can also higher education institutions in the developed countries enhance their focus upon development agendas such as the Plan of Action 2015? Particular reference will be made in this paper to best practices in the field of agriculture and forestry.

Keywords: Higher education, knowledge management, partnership, intellectual ownership

Quality Management Initiatives in Higher Education Institutions of SADC Countries

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The Southern Africa Development Conference (SADC) regional protocol on education has been ratified by all the member countries. The protocol emphasizes the importance of harmonizing the regional education systems and maintaining acceptable standards at all educational levels. This harmonization cannot take place smoothly until each education system takes stock of its own activities. This calls for the implementation of quality management in these institutions of higher learning. In addition, stakeholders in higher education have called for the accountability of the institutions as well as the cost-effectiveness of the programmes offered by these institutions while ensuring quality of delivery of education. Universities and other institutions of higher learning in the region are, therefore, setting up some mechanisms for the implementation of 'quality management'. 'Quality auditing' is the first step that has been suggested before the full implementation of quality management for the maintenance of high standards. Quality auditing will involve self-evaluation at institutional, faculty and departmental levels with respect to the mission, goals, objectives and activities for attaining them. The institutions of higher education in the SADC region have the potential to provide more and better training utilizing their tools and experiences. The challenge is to play a more active role and aim to gain leadership in their own field of expertise. The SADC region's Vice Chancellors had an opportunity in March 2003, of meet in Mauritius where they approved, in principle, the setting up of the mechanism for implementing quality management within the SADC institutions of higher learning. A regional workshop will spearhead this initiative in September 2003.

Keywords: Quality auditing, quality management, regional networking, SADC

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Delivering Systematic Information on Indigenous Farm Animal Genetic Resources of Developing Countries — The Development and Prospects of DAGRIS

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This paper describes the objectives, historical development, structure, functionality, content, utility and future prospects of the Domestic Animal Genetic Resources Information System (DAGRIS) of ILRI. This public-domain electronic database is designed to cater for the needs of researchers, policy makers, development practitioners, teachers, students and farmers in developing countries for efficient access to available published and grey literature from past and present research results on the origin, distribution, diversity, present use and status of selected farm animal genetic resources (FAnGR). It is currently available, free of charge, on the web as well as on CD-ROM. It is argued that information on the extent of existing genetic diversity, characteristics and use of FAnGR in developing countries is the basis for their present as well as future sustainable utilization. In developing countries, neglect and lack of accurate information on the diversity and status of the existing farm animal genetic resources are believed to exacerbate the alarming rate of irreversible loss of genetic diversity. Such losses reduce opportunities to improve food security, alleviate poverty and attain sustainable agricultural practices. The other known threats to their conservation are droughts, post-drought livestock restocking schemes that do not take account of undesirable consequences on the indigenous genetic resources, civil strife, well-meant crossbreeding programs that get out of control, lack of markets and gradual shifts in socio-economic settings of traditional communities, which happen to maintain the majority of the surviving indigenous farm animal genetic resources to date. The situation is alarming indeed because 16 % of the finite set of 7000 unique populations (breeds or strains) have been lost since the beginning of the 19th century, and a further 32 % are at risk of becoming extinct. Yet the rate of extinction, currently at two breeds per week, is expected to accelerate. The content and functionality of DAGRIS is designed to enlighten all stakeholders, in an efficient way, on the status as well as particularly useful attributes of recognised livestock breeds at the level of individual countries. It is also intended to provide the necessary decision-support tools for the development, sustainable use and conservation of selected FAnGR.

Keywords: Conservation, database, developing countries, domestic animal genetic resources information system (DAGRIS)

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Capacity Building Applied to a Livestock Research Network in West Africa to Enhance the Development Process

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The analysis of the development process in the agricultural sector of developing countries has often identified the limited capacity and/or lack of competent technical, scientific and extension personnel, isolation from sources of scientific information and limited opportunities for collaborative research as key constraints to the effective generation and dissemination of research outputs in form of improved and novel techniques and innovations for the benefit of the agriculture and livestock producer.

The International Trypanotolerance Centre (ITC) is a sub-regional Livestock Research Centre based in The Gambia, supporting applied Research and Development (R&D) in low-input and market-oriented livestock production systems in six countries in West Africa (The Gambia, Senegal, Guinea, Guinea Bissau, Sierra Leone and Liberia). The Centre has given, since its inception in 1984, strong emphasis to capacity building of technical, scientific and extension personnel in the NARS (National Agricultural Research Systems) and national Livestock Departments.

In the framework of the Centre's regional activities, particularly those supported by the EU-funded R&D programme PROCORDEL (Programme Concerté recherche-développement sur l'élevage en Afrique de l'Ouest), a concept has been adopted to overcome the constraints mentioned above. This concept links classical elements of Human Resource Development (HRD) in such a way that short-, medium- and long-term objectives in support of increased R&D efficiency are considered at the same time and in a regional context.

The main HRD elements are: training needs assessment of partners in research, training courses targeted at different levels of expertise and national qualification differences, regional mobility within the network, development of training materials with partners of the network, assessment of training impact, promotion of modern information and data management technologies.

The objectives are: immediate support to ongoing research activities through technical training of personnel involved in those activities (short-term); application of the Train the Trainer concept for research/extension personnel who in turn will be enabled to train farmers for the transfer and adoption of improved technological animal health and production packages (medium-term); career development through post-graduate training (long-term).

Keywords: Capacity building, HRD, research networks, training needs assessment, West Africa

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Impact of Farmer Learning Groups — A Participatory Approach in Integrated Pest Management in Egypt

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The bilateral Egyptian-German Integrated Pest Management Project started in 1992 with the objective of assisting in the design and verification of appropriate IPM contents in fruits and vegetables and the subsequent conveyance to small-scale farmers. During the first 3–4 years the project followed a conventional IPM approach which focused on pests and diseases. It relied to a large extent on classroom training and field demonstrations. The response from small-scale farmers and extension staff was limited and implementation of IPM measures low as was the overall impact. This resulted in remodelling the concept towards a more holistic approach of Integrated Crop Management (ICM). From 1996 onward a participatory, group based approach was introduced in which the farmer was placed in the centre. In so called Farmer Learning Groups (FLGs) they decide what topics are of interest and the group together with the village extension worker (VEW) seek solutions to occurring problems over a whole cropping season.

For this task VEW were trained in both technical topics and facilitation skills to enable them to lead the group during this time. Parallel to this a coaching structure was established to ensure the quality of the approach. Today, Master Trainers (MT) at national and regional level are responsible for co-ordinating the different programmes in 8 governorates in the Nile delta and Upper Egypt. Nearly 300 VEWs have been trained so far and more than 30,000 farmers attended FLGs. Currently an impact assessment with a total of 700 farmers cultivating mango, citrus, tomatoes and strawberries is ongoing.

Members of FLGs applying recommended IPM measures have bigger economic success than farmers who are not members of such groups. They are able to realize substantially higher gross margins through a combination of savings on inputs, higher yields and better qualities. In addition both farmers and extension staff appreciate the participatory extension approach because it allows them to interact better, establish professional relationships, introduce own ideas and improve their decision-making skills.

Keywords: Egypt, impact, integrated crop management (ICM), integrated pest management (IPM), participatory extension

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The Master of Science Sandwich Programme of International Animal Health

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The Department of International Animal Health of the Freie Universität Berlin establishes a new Master Course concept: Three courses address modern areas of veterinary medicine (epidemiology, veterinary public health, food chain management), aim at specific target regions and are jointly executed with partner universities and veterinary institutions in the regions.

The M. Sc.-VPH Course for the Southeast Asian Region will be launched with the beginning of the Academic Year 2003/2004 (October 2003) together by the partner universities Chiang Mai University (CMU) in Thailand and the Freie Universität Berlin (FUB); the University of Veterinary Medicine, Vienna/ Austria with its Institute of Meat Hygiene, Meat Technology and Food Science is the third and junior partner within the EU ASIA LINK Programme (providing substantial financial co-funding). Young and mid-career veterinarians and other professionals (natural, agricultural, medical sciences) from the Southeast Asian region with a background in and training needs for zoonoses control and food safety are the target group addressed by the M. Sc. programme. The course concept of a “twinning” or “sandwich” -programme is based on bundling of training institutions in Thailand and the countries in the region (South-South collaboration) under the leadership of CMU and in strong collaboration with the Northern partners FUB (South-North collaboration). The M. Sc. programme uses a modular curriculum structure to allow for state-of-the-art teaching of a particular topic as a combination of classroom knowledge transfer (lectures, group work, seminars, PC labs) linked to practical laboratory experiences (bench work) within a defined and uninterrupted time period at a particular partner institution.

The three Master Courses form the foundation for the establishment of the International Graduate School at the Faculty of Veterinary Medicine of FUB; expansion from the M. Sc. level to a led Ph. D. programme is to be achieved latest by 2007.

Keywords: International animal health, joint degree programme , M. Sc. programme, Southeast Asia, Thailand, veterinary public health

PhD Study Programme in Göttingen

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The Faculty of Agriculture of the Georg-August-Universität Göttingen launched the “International PhD programme for Agricultural Sciences in Göttingen (IPAG)”, which has a new curriculum concept and financially supported by DAAD and DFG in 2002. This international programme provides a first rate education that opens the way to a broad range of future careers, e.g., in teaching, research, administration, the private sector and in international development programmes.

IPAG is designed to offer PhD candidates specialized professional training and provides in addition to that modules in oral and written communication skills including scientific writing and publishing. IPAG also emphasizes soft skills like teamwork, problem solving and moderation techniques.

The doctoral programme runs 3 years until the PhD degree and begins each year in September. After an initial 12-months segment in which preparatory courses are offered, the candidates may conduct their research abroad where they work closely with highly qualified advisors. After completing 12 months of empirical research, candidates complete statistical analyses and write their dissertations.

The IPAG course programme consists of seven modules, of that two method courses, instructions providing specific knowledge in theory and methodology, modules preparing students structuring and writing a thesis and publishing scientific articles, an interdisciplinary series of seminars, three colloquia within each student presents the actual research data, and a workshop to improve soft skills needed in modern management practices.

The applicants must hold a master’s degree or its equivalent (awarded with honours) in agriculture or a related discipline. The PhD programme begins every year in September and the application forms are available via internet (www.ipag.uni-goettingen.de) or from the IPAG office.

Keywords: Agriculture, PhD programme, study in English

Improving the Access to Knowledge through Curriculum Development — The Experience of Armenian Agricultural Academy

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In March 2003, Armenian Agricultural Academy (AAA), after two years of activities, successfully concluded an EU Tempus/Tacis Curricula Development project directed towards the reform of economics disciplines through the introduction of new subjects and improvement of exiting ones. The project was contracted and coordinated by Hohenheim University, Germany and assisted by Wageningen University, the Netherlands with the financial support of the EU's Education Training Foundation. This poster depicts the accomplishments achieved during the implementation of the project covering wide range of activities. Thus, along with human capacity building, technical facilities such as a new computer centre, a new, unique language centre and an electronic library cataloging system, fully equipped with the latest computer hardware and software, were installed. They serve the purpose of supporting the more rapid implementation of the reforms in education at AAA, particularly restructuring the curricula of the Agricultural Economics Department. Enhancing the access to modern means of teaching and preparing the classes the project eased the access to knowledge and reinforced knowledge delivery techniques for the teaching staff, and raised the chances of students (future entrees into labor market) to get prepared according to modern requirements of the market economy. Academic staff and younger lecturers stayed in the West and developed lecturing materials and manuscripts which were later either integrated into existing subjects or served as a basis for the introduction of new study subjects/specializations which were promptly approved by the Ministry of Education and Science. Renown professors from the West, as well as from Russia delivered intensive lectures at AAA. Armenian students spent a semester and took part in a MSc-degree program in Hohenheim and Wageningen respectively. We strongly believe that sharing the experience of conducting successful, highly efficient activities would be of value to the students and the staff of education establishments in developing and transformation countries.

Keywords: Armenian agricultural academy, curricula development, economics, education reform, EU TEMPUS Tacis project

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Informal Advise Network of Urban Farmers in Kampala / Uganda — A Network Analysis of Social Relations

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Peri-urban and urban Farmers in Kampala/Uganda play a vital part for the food supply of the capital. In general they are small-scale farmers but they have to face distinct challenges. Phytopathological problems, labour intensive cultures or poor ways of marketing are evident, most of farmers are excluded of affordable credits for necessary investments or for inputs in production. In the context of previous structural adjustment programs and an insolvent state or capital district extension services could not reach most of the urban farmers. In this situation farmers have to develop their agriculture by their own. Farmers have to find appropriate solutions for these challenges by their own possibilities and demands. Informal and formal networks could give an answer at an organisational dimension to allocate resources or as an medium for the exchange of ideas, for planning and acting commonly. As a term a network is defined as a specific set of linkages among a defined set of actors, with the additional property that the characteristics of these linkages as a whole may be used to interpret the social behaviour of the actors involved. The concept of network analysis could work in this case study as a method to analyse existing social relations and structures in urban agriculture to identify and describe cohesive and dense groups, the degree of reciprocity between the farmers or different positions in the structure of the network. The research project took place in 2002 to analyse existing network relationships between farmers. Different networks of farmers had been identified and relevant relationships like the “network of phytomedical advise between farmers” has been analysed. It has been compared with the “neighbourhood network” of the same defined set of farmers. Apart from the formally network analysis attributes of farmers like age, gender, types of problems in agriculture or the availability of resources have been compared and discussed with the characteristics of the networks on individual, sub-group and network level.

Keywords: Agriculture, horticulture, network analysis, peri-urban, social relations, social structure, urban

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Agricultural Biotechnology — A Menace or Pathway to Sustainable Livelihoods in Developing Countries?

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Despite increasing availability of food globally, some 800 million people out of the global total of 6 billion are food insecure. The majority of these live in Asia (which accounts for 48 %), Africa (35 %) and Latin America and the Caribbean (17 %). Because access to food depends on income, the cause of food insecurity in the developing world is poverty. Agriculture constitutes, for the majority of the poor in developing countries, the primary means of survival and livelihood sustenance. Agricultural biotechnology offers enormous potential to achieve, in short time frames, increases in product quantity and quality that used to take years of laborious plant and animal breeding. However, biotechnology has, to date, remained a technology of the North. Properly harnessed, biotechnology represents perhaps one of the most powerful tools ever available to address the hitherto intractable food production constraints of the South. The major limiting factor to the application of biotechnology in the South is poverty. It is principally in the hands of the private sector in the North, the operations of which are driven by profit objectives. The private sector places a higher value on biotechnology products than on the biological resources, principally derived from the South, that are used to create the products. Current debate on biotechnology is focused on its potential negative impacts on human and environmental health.

The potential positive impacts of biotechnology on the lives of poor people, its appropriation in the North with little flow to the South and the lack of mechanisms for sharing the benefits derived from the exploitation of biological resources harvested from the South are receiving much less attention than they deserve. Like any new technology, the risks and benefits of biotechnology should be assessed in a Cost-Benefit Analysis framework. This presentation tries to answer the question: Is biotechnology a menace or an opportunity to address the pressing needs for sustainable livelihoods of poor people in developing countries? It examines the potential role of development assistance programmes, the responsibility of the research community to educate the public and of governments in the South to allocate resources and create enabling environments for the development of biotechnology, including human capacity, requisite policy and innovative partnership arrangements — especially public-private partnerships — that will facilitate North-South transfer of relevant biotechnology.

Keywords: Biotechnology potential, impact, food production, North-South transfer

Bt Cotton - Productivity Considerations from India and China

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By 2002 the global area planted to Bt cotton has reached 2.2 Mill ha and transgenic varieties become increasingly popular in developing countries. The main cotton producing countries China and India gave commercial approval for Bt cotton in 1997 and 2002, respectively and today Bt varieties have reached an estimated 50 % of the total cotton area in China. The Bt technology aims at preventing crop loss due to lepidopteran cotton pests, hence reducing the application of chemical pesticides and lowering production costs.

Previous studies, which assess the technology, claim a sharp reduction in pesticide use accompanied by significant human health and environmental benefits. But none of these studies captures long-term productivity effects or the stochastic nature of main parameters. A recent study on Bt cotton productivity in India does not even consider the production costs and product prices at all. Moreover, the validity to generalize study results from one region is questionable and analyses mainly based on short-term empirical studies might lead to wrong conclusions about the net benefits of Bt crops.

The analysis presented in this paper uses farm level data from Bt case studies in China and India (financial support was provided by the FAO). Based on plot level input data for cotton, production functions are estimated separately for each country. A damage control function following the approach of LICHTENBERG and ZILBERMANN is incorporated to account for the special nature of the Bt trait that is not directly yield increasing but prevents pest induced crop loss.

To adequately assess the farm level economic viability of the Bt technology it is necessary to account for uncertainty of main parameters. Some variables fluctuate following an underlying probability distribution (e.g. pest pressure and precipitation which determine the required irrigation or pesticide application and hence influence production costs). These variables are included as stochastic parameters in the simulation of gross margins.

The approach presented here complements existing analyses by including uncertainty aspects in the assessment of Bt cotton productivity.

Keywords: Bt cotton, productivity, technology assessment, uncertainty

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Towards Cloning of *Pup1* — A Major Locus for Tolerance to P Deficiency

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Phosphorus deficiency is a major abiotic stress limiting growth and productivity of rice in rainfed rice production areas throughout the world. It is associated with highly weathered, P fixing soils and low fertilizer use by resource-poor farmers. There is considerable genetic variation in rice with respect to its tolerance to P deficiency and ability to take up P from low-P soils. Developing cultivars with improved P-deficiency tolerance that would contribute to increased yield stability should therefore be feasible and molecular techniques may offer a more efficient way of obtaining this goal compared to traditional plant breeding methods. Previous studies have identified a major QTL for P uptake from a P deficient soil, *Pup1*. At present *Pup1* is thought to cosegregate with marker S10043 in a 0.8 cM interval defined by S13126 and S13752. The corresponding interval on the rice physical map spans 9 BACs, of which three have been fully sequenced at the time of writing. The availability of genome sequence data could facilitate efforts to clone the *Pup1* locus if potential target genes can be identified based on hypothesis on gene function. Physiological studies suggest that the *Pup1* gene is expressed in root tissue where it either leads to higher root growth per unit P (higher internal efficiency) or improves P uptake per unit root size (external efficiency). Available sequence data was screened for potential genes that would be related to internal or external efficiency. Several target genes were identified. The probability that any of those genes would be synonymous with *Pup1* is discussed based on additional evidence from physiological studies.

Keywords: Target genes, phosphorus deficient soil, rainfed rice production

Understanding Local Chicken Genetic Resources to Improve Livelihood

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The identification and understanding of local chicken genetic resources and the prevention of further loss of genetic variation in the face of the rapidly increasing demand for animal protein and related economic and market forces is an important task to improve livelihood in developing countries. Genetic diversity was assessed using 10 microsatellite markers between and within five different local chicken ecotypes originated from different agro-ecological regions and corresponding market sheds of Ethiopia, namely, Tilili, Horro, Chefe, Jarso and Tepi and the reference breed, Fayoumi. DNA was isolated from blood of 25 individuals from each of the five local ecotypes and the reference breed. The results of this study showed that all the microsatellite markers tested were highly polymorphic for all the tested ecotypes. The mean number of alleles from all microsatellite markers tested per ecotype varied from 4.2 (Jarso) to 5.3 (Chefe). The number of alleles detected per locus varied from 2 to 10 alleles. The calculated expected heterozygosity level showed high genetic variability in all tested populations. Heterozygosity varied between the lowest value of 55 % (Jarso ecotype) and highest value of 63 % (Tilili and Chefe ecotypes) for all the microsatellite markers tested. The genetic distance analysis result showed the presence of considerable genetic variation between the different ecotypes, however, the within ecotype variation was higher than the between ecotypes variation. Phylogenetic trees obtained using the genetic distance in both standard Neighbour-Joining (NJ) and UP-GMA methods assorted the ecotypes according their agro-ecological origins. The topography of both trees remained the same, but with higher significance level in NJ tree. Bootstrapping values were between 53 to 100 % in NJ tree and 43 % to 100 % in UP-GMA tree. In both trees, Fayoumi population formed a distinct branch on its own with high significance (100 %) level. The isolation by distance analysis based on normalised Mantel statistic showed a strong and positive correlation ($r = 0.62$) between the genetic distances and geographic distances matrixes.

Keywords: Biodiversity, genetic resources, local chicken, Ethiopia

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Development of an Efficient Virus Transmission Technique to Screen Cassava Genotypes for Resistance to Cassava Mosaic Disease

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The most important disease affecting cassava (*Manihot esculenta* CRANTZ) production in Africa is Cassava mosaic disease (CMD), caused by several whitefly-transmitted begomoviruses. Advancement in cassava breeding for virus resistance is hampered because screening for resistance to CMD is tedious, relying on natural infection conditions and on virus types at a given time and location. Therefore, developing an efficient inoculation technique with defined viruses at an early stage in breeding for resistance would provide a major improvement to the resistance development in cassava. All major begomoviruses in African cassava genotypes were collected, typed by sequence analysis and maintained as reference in cassava cultivars. For inoculation of begomoviruses into cassava, a graft inoculation approach, the biolistic inoculation of total DNA from virus infected plants and a biolistic delivery of cloned viral DNA A and DNA B genomic components were attempted. Graft inoculation technique was effective in inducing cassava with defined viruses, but only in successfully grafted plants. With ACMV (isolate number 84, from Democratic Republic of Congo-DRC), disease symptoms were observed around 3 weeks after grafting with resistant plants eventually showing symptoms after 10 weeks, however, with very low severity levels. Three cassava clones, TME 3, TME 4 and 91/02324 recovered from CMD and developed into symptomless plants. With EACMV-UG2 [Ke], clones 96/1087, 96/1089A and TME 4 mostly developed into symptomless plants with only very mild symptoms occasionally found on few leaves above the graft insertion. All leaf samples from grafted lines tested positive for virus infections in PCR and ELISA, however, virus detection in cassava that had recovered from infections failed. Biolistic inoculation (BI) of total DNA extracted from diseased cassava plants resulted in infected plants showing symptoms between 10 and 12 days after inoculation. Severe infections were induced in ISU by shooting DNA from ACMV-[DRC] and EACMV-UG2 [Ke] infected plants, indicating a synergistic interaction of the two virus species. Plants of TME 3 and TME 4 inoculated with mixed virus infections still recovered after a period of symptom expression. The biolistic delivery of cloned viral DNA was carried out, but not sufficiently effective to reach higher number of infected cassava plants compared to BI of DNA extracts from diseased plants. Infections were induced by EACMV-UG2 [Ke] clones (Ugandan variant) in the highly susceptible cassava breeding lines Isunikankiyan and 96/1039. The effectiveness of BI of DNA extracts over other transmission techniques in screening cassava genotypes is discussed.

Keywords: Biolistic inoculation, cassava genotypes, cassava mosaic begomoviruses, cloned virus, DNA extracts, graft inoculation

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Effect of Storage Temperature and Dehydration Induction Rates to Germeability of Sugarcane Synthetic Seeds

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Effect of storage temperature and dehydration induction rates on germeability of sugarcane synthetic seeds were investigated. Compact and white sugarcane (*Saccharum officinarum* L.) embryogenic callus developed from young leaf-rolled cultured on Murashige and Skoong agar medium supplemented with 3 mg/l 2,4-D, 50 mg/l cysteine and 5 % coconut water under dark condition at 25 °C. Initiation of embryogenic cell suspension achieved in liquid MS basal medium supplemented with 3 mg/l 2,4-D, 10 % coconut water and 400 mg/l casein hydrolysate and kept in continuous dark at 25 °C. The medium was replaced with fresh medium every 4 days interval to reduced accumulation of phenolic compound. Somatic embryos developed after 6 weeks when transferred embryogenic cell to fresh medium without 2,4-D under 16-h photoperiod. Mature somatic embryos were encapsulated in 3 percent sodium alginate for synthetic seeds production. Sugarcane synthetic seeds were stored in 3 different temperatures (4+1, 15+2 and 25+2 °C) under 16-h photoperiod for 4 weeks. It was found that synthetic seeds stored at 4+1 °C for 4 weeks showed no precocious germination or death during storage and could be germinated at 35 percent. A hydrated synthetic seeds retained enough water for the encapsulated somatic embryos to germinated during storatation. However, germination was blocked when hydrated alginate capsules were dehydrated. It was found that desiccated synthetic seeds with siliga gel until 80 percent water loss showed no precocious germination and could be germinated at 27 percent after stored for 4 weeks. Therefore, storing hydrated sugarcane synthetic seeds in 4+1 °C and dehydration with silica gel until 80 percent water loss, which might be especially useful for prevent precocious germination during short term sugarcane synthetic seeds storage.

Keywords: Hydrolysate, phenolic compound, somatic embryo, synthetic seed

Possibility of Sugarcane Synthetic Seed Production

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Sugarcane (*Saccharum officinarum* L.) is well known as an extremely important crop plant. Using the stem of mature sugarcane has been the only practical means of propagating sugarcane. This method is vary expensive in term of labor costs and can also produce problems in term of spreading virus diseases such as Fuji disease, bacteria diseases such as red rot and the main fungal disease of smut. A model system of synchronous somatic embryos production combined with formation of synthetic seeds was studied for sugarcane. Compact and white embryogenic callus developed from portion of young leaf-rolled cultured on Murashige and Skoong agar basal medium supplemented with 3 mg/l 2,4-D, 50 mg/l cystein and 5 % coconut water. Embryogenic cell suspension culture were established by placing 3 months old embryogenic callus to liquid Murashige and Skoong basal medium supplemented with 3 mg/l 2,4-D, 10 % coconut water and 400 mg/l casein hydrolysate. The suspension culture were subcultured at 7 days interval by transferring 10 ml of the middle portion of suspension added to 25 ml of fresh medium. Somatic embryos developed after 6 weeks when transferred embryogenic cell to fresh medium without 2,4-D under 16-h photoperiod. Individual somatic embryo was encapsulated by 3 percent sodium alginate was approximately 4–6 mm in diameter. The germination of synthetic seeds were 60 % on Murashige and Skoong medium. Germination sugarcane synthetic seeds produced normal plantlet. This result indicated that somatic embryos from cell suspension culture could produced a lot of synchronized somatic embryos in short time. Therefore more research for better technique might be suggested.

Keywords: Embryogenesis, somatic embryo, sugarcane, synthetic seed

Induced Desiccation Tolerance by ABA Treatment in Sugarcane Somatic Embryos

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The preservation of viability and vigor of somatic embryos is one of the problems, which still has to be solved prior to practically applying synthetic seed technology. The encapsulation of the somatic embryos does not prevent precocious germination and short storage period. Loss of water from somatic embryo tissue brings it to a metabolically inactive or quiescent state. Sugarcane (*Saccharum officinarum* L.) embryogenic callus was initiated from young leaf-rolled cultured on Murashige and Skoong agar medium supplemented with 3 mg/l 2,4-D, 50 mg/l cystein and 5 % coconut water under dark condition at 25°C. Embryogenic cell suspension culture achieved in Murashige and Skoong liquid basal medium supplemented with 3 mg/l 2,4-D, 10 % coconut water and 400 mg/l casein hydrolysate and kept in continuous dark at 25°C. Desiccation tolerance of sugarcane somatic embryos was induced by exogenous application of abscisic acid (ABA). Somatic embryos were treated with various ABA concentration for ten days prior to dehydration by silica gel to formed dried synthetic seeds. Treated somatic embryos were encapsulated with 3 percent sodium alginate and dehydrated with silica gel until 80 percent water loss, respectively. The germeability of dried synthetic seed was varied on the ABA concentration, dried synthetic seeds showed germination rate at 53 percent when treated with 0.1 mg/l ABA. Pretreatment sugarcane somatic embryos with 0.1 mg/l for 10 days prior to encapsulation, then dehydrated by silica gel until 80 percent water loss resulted germeability at 32 percent without dead or precocious germination after 3 weeks of storage at 25°C. These results indicate that the pretreatment with ABA can maintain germeability of dried sugarcane synthetic seed after short storage period.

Keywords: ABA, desiccant, germeability, somatic embryo

Economic Effect of the Genetic Modifications Bt and Rr in Corn Crops for Seed Purposes

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The great advance of the agriculture in the last decades has been due mainly to the incorporation of technology to productive processes. Among these, the biotechnology through genetic modifications has undoubtedly given place to the transgenic and genetically modified organisms. It has allowed to transfer genes of agronomic importance to organisms, which confer them — among others properties — tolerance to herbicides or resistance to illnesses or plagues. This would influence significantly in the increasing of profits and the value of crops with such characteristics. Nowadays, there are studies that have tested that the GMO have enlarged the productivity, reducing the conventional use of pesticides, diminished the number of cultivation activities, with the consequent savings of time, labor and use of machinery. Summarizing, it have had an economic impact — and even environmental — on the productivity of some crops. All of this should be translated in a decreasing of production costs in some crops, especially, the ones that have seen in the last decade a systematically fall in their prices in the international markets. In the case of Chile, the legislation only allows the multiplication of GMO vegetable species whose final product, the seed, should be exported. Given this framework, the present study considered as a main objective to make a comparison between the corn production costs for seed not modified genetically and that modified Bt (resistance to insects) and RR (resistance to herbicide). From this comparison, the main differences in the variable costs of production of the two forms of crops were established. This allows us to construct a scenery of the potential economic benefits that would have in Chile the liberation to the market the usage of genetically modified maize seed for grain production, allowing in this way to increase the competitiveness degree of Chilean producers.

Keywords: Competitiveness, cost of production, economic production, genetic modifications

Responses of Four Salak Genotypes (*Salacca zalacca*) to Different Growing Media

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Salak belongs to a group of palms which do not form trunks, but rather sprout their leaves from ground level. The plant is 1.5–5 m high, erect, heavy headed and extremely spiny. Salak palms grow as under-storey plants in the low lands of the tropical rain forest in Indonesia and other Southeast Asian countries. In Indonesia, salak has been cultivated throughout the islands and the fruit is widely used as fresh fruit. One important salak cultivar in that area is “pondoh” due to its superior quality. The salak fruit is small in size (about 5 cm in diameter), enclosed a whitish translucent edible portion which resembles the taste of banana and pineapple. The peculiar fruit peel, which is similar to a reptile skin is the reason for the name “snake fruit”.

To maintain the genetic resources and to promote the production, knowledge about eco-physiological aspects are important. The purpose of this study was to investigate the responses of different salak cultivar seedlings to a variety of plant growing media: sand, peat moss and compost: sand (1:1). Four month-old seedlings of four different salak cultivars from Indonesia, i.e. “Pondoh Super”, “Pondoh Hitam”, “Pondoh Manggala” and “Gading Jawa” have been used as test plants. The experiment has been conducted from December 2002 until March 2003 in the greenhouse of Department of Fruit Science in Berlin. The responses of growth (increment of leaf area, shoot length, dry weight of root and dry weight of shoot), leaf gas exchange, leaf colour and plant mineral contents (nitrogen, phosphor, calcium, magnesium and potassium) to different plant growing media will be presented and discussed.

Keywords: Salak cultivars, plant growing media, Indonesia

Generation and Characterisation of Recombinant Antibody Fragments Against Non-Structural Proteins of Potato Leafroll Virus

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Molecular biotechnology has provided powerful new measures for the control of crop disease. Crops can now be engineered to be resistant through creation of transgenic plants producing recombinant proteins, pathogen related proteins, or antisense RNAs that block pathogenesis. The principle of generating resistant plants by genetic engineering is to express a protein or nucleic acid that interferes with pathogenesis in a transgenic plant. However, this strategy bears a recombination or transcapsidation risk which can occur between the resistance-mediating transgene and an innocuous virus and so leading to increase virulence. For example viroid RNA can be encapsidated within *potato leafroll virus* (PLRV) particles. Therefore, these approaches can only cautiously be used, and alternative strategies should be employed that do not share this risk.

In contrast, antibody engineering is a novel approach to create pathogen-resistant plants, which is based on the expression of recombinant antibody fragments that inactivate pathogens and pathogen proteins. The effectiveness of antibody-based resistance is related to the antibody affinity and specificity to the target protein. Antibody-mediated resistant plants provide higher security levels and avoid the use of undesirable pesticides currently used in agriculture. PLRV, a member of the family *Luteoviridae*, is transmitted by aphids and confined to the phloem tissue of the host plant. In the course of infection, PLRV produces yellowing and leafrolling symptoms diminishing crop yield. Monoclonal antibodies (mAb) against different PLRV proteins were isolated and used for generating single-chain fragments of the variable domains (scFv). The variable heavy chain (VH) and variable light chain (VL) coding sequences were cloned by RT-PCR in a bacterial expression vector. After periplasmatic expression in *E. coli* the soluble scFv were isolated and purified via Ni-NTA affinity chromatography. The purified scFv were evaluated through Western blot and ELISA analysis demonstrating specific binding to selected recombinant viral target proteins.

The obtained scFvs were identified as promising candidates to establish resistance against PLRV upon engineering transgenic potato plants which is currently ongoing to study the relevance of the different PLRV proteins during the PLRV infection cycle.

Keywords: Potato leafroll virus (PLRV), antibody engineering, single-chain fragment of variable domain (scFv)

Towards a Molecular Identification and Transfers of Fruit Quality in Indonesian Pineapple Land Races

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Pineapple (*Ananas comosus*) is amongst the important introduced fruits in Indonesia. This fruit is consumed both as fresh and processed product. Indonesia is not the center of origin of pineapple. Therefore, a wide hybridization between Indonesian pineapple land races that adapted to the Indonesian environment for centuries and newly introduced pineapple possessing quality of fruit, is one of the possible tools for improving Indonesian pineapple gene pool. The plant breeding lab of Padjadjaran University and Bogor Agriculture University started a collaborate pineapple breeding program since 1999. Both molecular analysis and hybridization were conducted. The breeding strategies are: i) Estimation of genetic distance based on morphological traits and DNA analysis, ii) Parental screening based on genetic distance and desired traits, iii) Hybridisation of selected parent, iv) Progeny selection, and v) Vegetatively propagation. Direct and indirect selection on fruit quality and yield was determined based on correlation between vegetative traits and fruit quality yield. Genetic distance of 35 pineapple genotypes had been estimated from morphological traits and RAPD. Four genotypes of Queen were selected to hybridize with local Subang pineapple (*Cayenne*) in order to improve the quality of subang pineapple. Reciprocal hybridization between Queen and Cayenne was also held in nursery of College of Agriculture, Padjadjaran University, Bandung, Indonesia. Indirect selection of progeny had been done based on length of leave, width of leave, and diameter of canopy since these three characters correlated with fruit weight, vitamin C, and sugar content of fruit. Selected progeny was planted and direct selection of yield and fruit quality would be done about ten months later.

Keywords: Indonesia, land races, molecular identification, pineapple, transfer fruit quality

A Rapid Way of Physical Mapping in Coconut and Oil Palm

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Coconut (*Cocos nucifera* L.) and oil palm (*Elaeis guineensis* JACQ.) are the two most important perennial oil crops. Both crops are being studied in an EC-funded INCO-DEV (International Cooperation with Developing Countries) project with the title: “Construction and exploitation of high density DNA marker and physical maps in the perennial tropical oil crops coconut and oil palm: from biotechnology towards marker-assisted breeding” (LINK2PALM). The objectives are (i) to provide the methodological basis and molecular tools for improving the breeding efficiency in both crops, (ii) to develop DNA marker-based breeding strategies in collaboration with the most important countries in coconut and oil palm production and (iii) to directly transfer to developing countries small-scale technological solutions for the genetic improvement of these tropical oil crops. As a basis to achieve these objectives, high-density (HD) molecular linkage reference maps are being developed for standard mapping populations in coconut and oil palm. These individual reference maps serve for (i) their integration into a general reference map for both crops, (ii) QTL analyses and (iii) physical mapping approaches. Usually in a physical map, defined individual DNA fragments of the crop’s genome are ordered and anchored on a linkage map in a way that contiguous regions of overlapping sequences are formed. These maps are useful for genome-wide gene discoveries like map-based cloning of interesting genes, and provide an efficient prerequisite tool to enable marker-assisted selection on important traits in future breeding programs. To develop a physical map, genomic libraries of oil palm and coconut have been constructed consisting of more than 120,000 individualized cosmid clones each (2–3 genome equivalents). Out of these libraries, in house developed software and commercial robots were used to assemble 28,800 individualized COS clones into 30 8-dimensional pools which are currently used for associating single COS clones of genomic DNA to linkage-mapped AFLP markers. With such a multi-dimensional pooling system a minimum of PCR reactions is required. In this efficient way it seems to be feasible to speed up the time-consuming process of physical mapping, and, so far, the time expense to create new breeding lines based on targeted genomic information.

Keywords: Cosmid library, linkage maps, molecular marker, oil crops, physical mapping, pools

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Investigation of Avian Mycoplasma Infection in Vietnam by Molecular Tools

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Poultry production plays an importance role in Vietnamese animal production. The main system for raising poultry in Vietnam is mainly based on low-input low-output system in small household. Such systems are currently bringing a certainly economic importance in poultry production but they are characterized by high incidence of disease. The Chronic Respiratory Disease and synovitis are caused by *Mycoplasma gallisepticum* (MG) and *Mycoplasma synoviae* (MS) in chicken and turkey are the diseases that causes a tremendous economic loss in Vietnam. The control of these diseases depend largely on early detection and eradication. Recently, a number of molecular diagnostic methods were developed in our institute in order to increase the sensitivity of mycoplasma detection. A nested PCR for the detection of MG, the main pathogen, was set up. The test reaches the limit of less than 5 CFUs/reaction, a multiplex PCR protocol and a PCR-RFLP procedure were set up for avian mycoplasma detection and strain differentiate with high sensitivity and accuracy. Our results shown that there are clear difference of MG infection between two seasons of study (90 % in spring and 20 % in autumn). There is a significant difference between two systems of poultry production in spring, the large scale (75 %) and extensive production (87 %). Interestingly, all of the pathogen avian mycoplasmas were found in Vietnam. The method enable us to detect the bacteria not only in swab sample but also allow us examine in other type of specimen such as yolk, embryo, water, litter.

Keywords: Avian mycoplasma infection, detection tools, PCR sensitivity

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Economics of AnGR Conservation and Sustainable Use — Importance and Application

ADAM DRUCKER

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Animal genetic resource (AnGR) diversity contributes in many ways to human survival and well-being. However, 32 % of livestock breeds are threatened. Such an irreversible loss of genetic diversity reduces opportunities to improve food security, reduce poverty and shift towards sustainable agricultural practices.

The large number of AnGR at risk in developing countries, together with the limited financial resources available for conservation, means that economic analysis can play an important role in ensuring an appropriate focus for conservation efforts. In this regard, important tasks include, inter alia: 1) determining the economic contribution that AnGR make to various societies; 2) supporting the assessment of priorities through the identification of cost-effective measures that might be taken to conserve domestic animal diversity; and 3) assist in the design of economic incentives and institutional arrangements for the promotion of AnGR conservation by individual farmers or communities.

Nevertheless, despite the importance of the economics of AnGR conservation and sustainable use, the subject has only recently begun to receive attention, despite the existence of a conceptual framework for the valuation of biodiversity in general.

Having described the theoretical background, this paper briefly discusses the potential methodologies, data requirements and difficulties confronted in carrying out such studies. The paper then concludes by analysing the results of a range of economics of AnGR studies recently carried out in Africa, Latin America and Europe.

These studies reveal that not only are there a range of methodologies that can be used to value farmer breed/trait preferences, but that they can in fact be of use in designing policies that counter the present trend towards marginalisation of indigenous breeds. In particular, it becomes possible to, inter alia: recognise the importance livestock keepers place on adaptive traits and non-income functions, and the need to consider these in breeding programme design; identify those breeds that are a priority for participation in cost-efficient diversity-maximising conservation programmes; and contrast the costs involved with the large benefits non-livestock keepers place on breed conservation.

The challenge is to now apply further work of this type in contexts where the results can actively benefit livestock-keepers, national researchers and policy-makers.

Keywords: Economics of AnGR conservation, sustainable use

Towards Agricultural Diversification and Rural Poverty Alleviation — Development of Integrated Agri-Aquaculture Farming in the Mekong Delta, Vietnam

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There is considerable potential to integrate aquaculture with existing agriculture practices in the Mekong Delta. Development of integrated agriculture-aquaculture (IAA) farming systems will diversify agriculture and alleviate rural poverty that are considered as one of crucial strategic directions for rural development in the region. This review will describe agricultural status in general and factors from which agricultural diversification and rural poverty alleviation is required in the context of the Delta. Agricultural diversification would crucially contribute to sustainable livelihoods of poor farm households and rural poverty reduction through diversified agricultural activities and best use of local labour force, increased and diversified farm income, improved food production, and minimized environmental degradation.

The paper will describe existing small-scale IAA farming systems in the Mekong delta. Factors such as physical conditions, available nutrient sources, farm household's resources and livelihood strategies, influencing the integration and roles of aquaculture within the systems will be analyzed. Both scientific results and farmers' perception have shown economical, social and environmental benefits of IAA farming systems. Nutrient recycling of otherwise unused waste materials is an important benefit of this integrated farming. Integration of an aquaculture component into existing agriculture systems improves the overall nutrient retention of the system. In consequence, both the aquatic and terrestrial crops are benefited in the integrated farming system.

Although the IAA farming has been advocated, poor farmers still need to solve numerous constraints. Researchers and extensionists have to provide farmers context-specific holistic information packages of different production options rather than technology only. Moreover, the classical top-down transfer of technology should be replaced by farming system research and extension approach.

Keywords: Agricultural diversification, integrated agriculture-aquaculture farming, Vietnam

Sustainable Natural Resource and Crop Management in Intensifying Cereal-Legume Production Systems in the Moist Savannas of West Africa

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The moist savannas of West Africa have high potential for the production of cereal and legumes crops because of favourable environmental conditions for their optimal growth. Despite this high potential, the yields obtained under farmers' conditions are still very low. In response to land use intensification, soil degradation and nutrient depletion have gradually increased and become serious threats to food production in these cropping systems. Increased incidence of the parasitic weed *Striga* spp. is considered another indicator of degraded soils. The *Striga* problem in West Africa is intimately associated with the intensification in land use, reflected in an increase in mono cropping and reduction in fallow periods. Since the mid 1990s, it has become clear that in order to upgrade crop production to the levels needed to sustain the growing population without further degrading the soil resource base, targeted application of inorganic fertilizer is required. However, the use of inorganic fertilizers is limited in the West African savannah due to their prohibitive cost compared to the grain price. In addition, recurrent droughts in the West African savannah pose a widespread risk to crop production. These factors combined with the widespread use of unimproved crop varieties and inadequate use of inputs contributes to the low crop productivity in the region.

Over the last ten years, substantial knowledge has been gathered on soil management combined with solid crop improvement and plant health research at farmers' level. This knowledge has made it possible to address with confidence intensification of cereal-legume based cropping systems in the moist savannas of West Africa in a sustainable manner. This paper gives examples of how resilient crops coupled with improved land and pest management practices can lead to sustainable intensifying cereal-legume production systems in West Africa.

Keywords: Cereal-legume rotation, cereals, drought, grain legumes, savannah, *Striga*

Introduction of Agricultural Technologies — Did It Cause Land-Use Changes and Poverty Reduction in the North-Western Upland of Vietnam?

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Before economic innovation or “Doi moi”, north-western upland of Vietnam was characterized by complicated terrain, diversity of culture, high illiteracy, severe environmental degradation, and poor infrastructure facilities. Livelihoods of rural upland communities were maintained through a combination of hillside swidden agriculture with low productivity, forest product exploitation and limited wet rice production. Access to available, new agricultural technology was extremely limited. Poverty was widespread in the region. However, development in this region has gained some remarkable achievements since 1990 and the acceptable explanation is contribution of agricultural technology. This paper examines to what extent introduction of access to agricultural technology and extension services, and adoption rate contributed to changing land-uses and alleviating poverty at 75 communes of Son La province from 1989 to 2000. The aerial photographs and satellite images taken in 1989, 1995 and 2000 are interpreted to detect land use changes. Poverty is proxied by the number of assets controlled by the poor, which are collected at the commune level by means of a survey with a structured questionnaire. All data are geo-referenced and spatially analyzed by using Geographical Information System (GIS) and statistical software. The research findings show that lack of suitable technologies (e.g. improved breeds of crops and livestock and new farming techniques) and agricultural extension services hindered agricultural potentials of the region and forced the local farmers into pursuing extensive farming approach at the expense of forests and other natural resources. That was why vast area of forest was destroyed both for agricultural cultivation and forest products from 1989 to 1994 whilst poverty was still resistant at a high rate. Thanks to improvement of access to modern agricultural inputs and extension services, subsistent and low productive crops have been replacing by highly yielding and more profitable varieties since mid-1990s. Agricultural production has boomed. As results, living standards of local inhabitants were considerably improved and deforestation was decreased. However, rates of technological adoption, land-use changes and poverty elimination are not the same pattern at all communes. Therefore, this research also provides some recommendations to enhance effectiveness of current agricultural extension services.

Keywords: Extension services, GIS, land-use change, technology adoption, Vietnam

Managing Seasonal Soil N Dynamics in Rice-Wheat Cropping Systems of Nepal

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The rice-wheat annual double cropping system occupies some 0.5 million ha in the Himalayan foothills of Nepal. Alternating soil drying and wetting cycles characterize the 6–10 week-long dry-to-wet season transition period (DWT) after wheat harvesting and before wetland rice transplanting. Mineral fertilizer use in the predominant smallholder agriculture is low and crops rely largely on native soil N for their nutrition. Changes in soil aeration status during DWT are likely to stimulate soil N losses. The effect of management options that avoid the nitrate build-up in soils during the eight weeks DWT by N immobilization in plant or microbial biomass was studied under field conditions in Rampur, Nepal in 2002. Treatments included bare soil (farmers' practice), green manure (*Mucuna pruriens* var *utilis*), grain legume (*Vigna radiata* L.), wheat straw (5 Mg ha⁻¹) and combinations of straw application and transition season crops. The gradual increase in soil moisture with the onset of the rainy season resulted in a nitrate peak of about 60 kg N ha⁻¹ that rapidly declined and nearly completely disappeared with soil moisture levels exceeding 46 % water-filled pore space. Incorporation of wheat straw and/or N uptake by green manure crops reduced nitrate accumulation in the soil to < 30 kg ha⁻¹ (temporary N immobilization), thus reducing the risk for N losses to occur. This "saved" N benefited the subsequent crop of lowland rice with increases in N uptake at least 37 kg ha⁻¹ and corresponding grain yield increases from 1.7 to 3.0 Mg ha⁻¹. While benefits from improved soil N management on lowland rice are obvious, possible carry-over effects on wheat and the feasibility of proposed options at farm level require further studies.

Keywords: Biological nitrogen fixation, denitrification, *Mucuna*, *Oryza sativa*, *Triticum aestivum*, *Vigna radiata*

Sustainable Marine Aquaculture in Tropical Waters with New Concepts and Technologies? — Lessons Learnt from a Mass Fish Kill

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Extreme ups and downs of marine fish and shellfish aquaculture in SE Asia have led many scientists to question its principal sustainability. Impacts of new technologies about organic waste recycling processes in marine environments have yet to be analyzed and exploited. Monitoring of both internal and external effects of intensified marine aquaculture will require conceptual and technical adjustments, as current routines of ecotoxicological risk assessment tend to prove insufficient. In 2002 a massive fish kill affected net cages and pens with milkfish at Bolinao (Philippines). A retrospective analysis suggests that mass mortality of cultivated and wild fish had been caused by the same factors. This analysis illustrates fundamental differences in predictability and sustainability between land-based and marine production systems. Due to considerable tidal water exchange, the widespread net cages are essentially open systems. As these are closely linked with the sediments underneath, also benthic environments become integral parts of the net cage production systems. Criteria currently monitored in the assessment of ecotoxicological risks, nevertheless refer mainly to water quality. Proper consideration of benthic processes would eliminate such conceptual shortcomings. Coastal marine sediments not only offer the advantage of a fixed spatial reference base, they also harbor most ecological risk factors. These emanate from their role as recycling “hot spots” for organic waste when mineralization via sulfate reduction produces ecotoxic hydrogen sulfide. Furthermore, potentially harmful microorganisms tend to be conserved in sediments as repository sites of most dormant or resting cell stages including the cysts of harmful bloom-forming algae (toxin-producing “red tide algae”). New technologies such as multiple culture systems representing almost complete food chains, may reduce the accumulation of organic waste, but are most likely to become less intensive, though not less vulnerable, than conventional mariculture. There is considerable scope for bioremediation to improve the recycling capacities for organic waste within a net cage or fish pen. Sustainability may further be enhanced by integrating “external” natural resources such as seagrass meadows or mangrove vegetation. By means of their rhizosphere microflora these aquatic plants have the potential to become instrumental in favoring biogeochemical pathways other than sulfate reduction in organic matter recycling.

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Keywords: Mariculture, hypoxia, red tides, organic waste recycling

The Effect of Substituting Fish Meal on Threonine Requirement in Diets for Nile Tilapia (*Oreochromis niloticus*) Derived by an N-Utilisation-Model

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This study reflects a further step to adapt a physiological based N-utilization-model to growing fish by comparing the threonine requirement calculated for threonine efficiency from fishmeal (FM) and soybean meal (SBM).

After logarithmization of the basic function the requirement of the limiting amino acid (LAA) can be calculated depending on actual $PD_{max}T$ (genotype), utilization rate of $PD_{max}T$ (growth performance) and efficiency of the LAA (bc^{-1}).

$$(1) x_{LAA} = [\ln PD_{max}T - \ln(PD_{max}T - y)] : 16bc^{-1}$$

Where:

$$x_{LAA} = \text{daily LAA-intake} / BW_{kg}^{0.67} \text{ (mg)}$$

$$PD_{max}T = \text{maximum of theoretical capacity for daily N-deposition} + NMR/BW_{kg}^{0.67} \text{ (mg)}$$

$$y = \text{daily N-deposition} + NMR / BW_{kg}^{0.67} \text{ (mg)}$$

b = slope of the curve (= protein quality)

c = dietary concentration of LAA (g / 16 g N)

$$NMR = \text{N-maintenance requirement} / BW_{kg}^{0.67} \text{ (mg)}$$

Based on our actual results about $PD_{max}T$ a growth trial was conducted with male Nile-Tilapia (mean BW = 12.6 g) assigned to 30 tanks (25 fishes/tank) in a recirculating unit. 6 semi-purified, isonitrogenous diets (31–32 % CP; 14–15 MJ ME/kg), designed to be limiting in threonine (= LAA), were applied for 56 days. Protein deposition was determined based on the whole body composition of representative animals.

Depending on level of performance, the calculated threonine requirement data vary over a wide range. For a fixed level of daily N-deposition a lower efficiency of threonine (SBM) requires an increased threonine uptake in order to achieve similar growth comparing to a feed protein with a high efficiency of threonine (FM). The results indicate a lower threonine requirement, mainly under extensive production regimes and inclusion of threonine sources with high amino acid efficiency.

Keywords: Tilapia, amino acid requirement, amino acid utilisation, threonine

Use of Lemon Oil as Feed Additive in Weaner Pig Diets

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Lemon oil is an essential oil extracted from lemon fruit (*Citrus aurentiifolia* SWING). Some of effective ingredient in lemon oil has been seen to be effective in reducing the colony of some micro organisms, which may cause the diarrhoea in piglets. An experiment was conducted at Chiang Mai University, Thailand to determine the use of lemon oil as feed additive in weaner pigs. Thirty, 28 day old weaner pigs weighing on average 9 ± 0.8 kg were randomly distributed into 5 groups of 6 animals each. The pigs were housed in individual cages. The pigs were allocated by group to the five diets: 1. Control basal diet containing corn-soybean meal; 2. Basal diet supplemented with 1 g tetracycline kg^{-1} feed; 3. Basal diet plus lemon oil (LO) at 1 ml kg^{-1} ; 4. Basal diet plus LO at 2.5 ml kg^{-1} ; and 5. Basal diet plus LO at 5 ml kg^{-1} . The experimental diets were formulated according to NRC (1998) requirements. The growth performance and faecal characteristics of the pigs were determined for 35 days. Average daily gain (ADG) and feed conversion ratio (FCR) of pigs fed diets 1 to 5 were: 467, 493, 458, 469 and 446 g d^{-1} and 2.46, 2.32, 2.38 2.48 and 2.32 respectively. There were no significant ($p > 0.05$) differences in ADG and FCR amongst the treatments. The inclusion of lemon oil at 5 ml kg^{-1} diet tended to improve FCR and faecal shape score values compared to the control. The results suggest that lemon oil can be included at 5 ml kg^{-1} in weaner pig diets and has potential to act as tetracycline as feed additive in weaner pig diets.

Keywords: Essential oil, feed additive, lemon oil, weaner pig

Effect of Yoghurt on Colibacillosis Treatment in Piglets

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E.coli (colibacillosis) infection in neonatal pigs is widespread through pig industry in Thailand and causes enormous economic losses. Good management is important in controlling development of disease. This includes good hygiene in the farrowing quarters, washing the sow before entry to the farrowing quarters, adequate heating for piglets, access to colostrum immediately after birth and vaccinating sows prior to farrowing. In cases of illness, treatment usually relies on antibiotics which act on pathogenic microorganisms in the digestive tract. However, from antibiotic administration normal flora important for fermentation may be negatively affected. This study was carried out to evaluate potential use of *Lactobacillus* spp. in the form of yoghurt to treat piglets from colibacillosis. Piglets, 1–14 days old, from 28 sows that showed signs of diarrhoea were randomly divided into two groups: 1) 91 piglets were treated with yoghurt and 2) 60 piglets were treated with antibiotic. Yoghurt was given orally twice a day, 5 ml/dose on the first day and 10 ml/dose on the following days. Antibiotic (enrofloxacin) was given by intramuscular injection, once daily in dose of 25 mg/piglet. Duration of treatment depended on evident signs of diarrhoea. Most of the piglets recovered from diarrhoea within 3 days. Treatment efficacy of yoghurt and antibiotic were not different. However, cost of treatment per animal by using yoghurt was lower than that of antibiotic. This suggests that yoghurt can be used for colibacillosis treatment in piglets instead of antibiotics which have potential problems of drug resistance in pigs and antibiotic residue problem in humans.

Keywords: Colibacillosis, piglet, yoghurt

Utilisation of Soybean Hulls as Dairy Cattle Feed

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The study was conducted to determine the chemical composition, rumen degradability and *in vitro* digestibility of soybean hulls. Soybean hulls were incorporated at 0, 20, 40 and 60 % of the total rations and offered to four rumen fistulated crossbred Thai Indigenous x Holstein Friesian dairy cows of average 416 ± 54 kg in a Latin Square Design study. Rumen degradation of soybean hulls was determined using the nylon bag technique and the digestibility using Menke *in vitro* gas technique. The soybean hulls contained 88.71 % DM. The composition of the soybean hulls as percentage of DM was 95.42 % OM, 11.42 % CP, 3.57 % EE, 24.75 % CF, 39.03 % NDF and 27.78 % ADF. The results from nylon bag technique showed that the potential DM degradability of soybean hulls was very high (99.35 %) and the effective degradation at 0.05 hr^{-1} was 56.25 %. When supplemented at 60 % in the diet, the effective degradation of DM, OM and CP were relative higher than at 0, 20 and 40 %. The estimated DMI, DDMI, growth rate and index value also followed the same trend. The prediction values of OMD were 73.27, 73.04, 70.80 and 69.13 %, respectively, ME values were 11.98, 12.20, 12.00 and 11.59 MJ/kg DM, respectively and NEL values were 7.45, 7.64, 7.49 and 7.20 MJ/kg DM, respectively at 0, 20, 40 and 60 % inclusion. The values tended to decrease at higher levels of soybean hulls supplementation. Ammonia nitrogen level in the rumen at 1h after feeding was significantly higher ($p < 0.05$) at 0 % soybean hulls diets than at 30 %. However, at 3h after feeding the ammonia nitrogen level in the rumen at 30 % soybean hulls was significantly higher ($p < 0.05$) than at 20 % soybean hulls diet. Total volatile fatty acid tended to decrease at the higher levels of soybean hulls in the diets. It is concluded that soybean hulls can be supplemented at 3 % of the ration of dairy cattle.

Keywords: Dairy performance, nutrient digestibility, rumen degradability, soybean hulls

Small Scale Milk Processing — A Business Benefiting to Both Dairy Farmers and Consumers

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Since 1996, small scale milk processing has been introduced in the Kolda region, Casamance, Senegal. The first pasteurization unit has been put in place with the help of Vétérinaires Sans Frontières. Up to now, there are five units in Kolda, two in Tambacounda, three in Vélingara and one in Kédougou. The establishment of these pasteurization units initiated (1) the implementation of an effective milk collection system with better possibilities for milk producers to commercialize their products and (2) the availability of new dairy products of better quality.

This study intended to characterise the different pasteurisation units and the supplying milk collection system. Emphasis was put on the evaluation of the effectiveness of the applied methods of milk pasteurization and processing. The existing pasteurisation units can be classified into different categories: traditional, slightly advanced and advanced, depending on input in equipment and technical skills. These categories are also reflected in the quality of their products.

Bacteriological analysis was performed on milk before and after the pasteurisation/cooling process. Results of raw milk samples (n=196) showed high counts of mesophilic bacteria (87.8 % above 2×10^6 cfu/ml) and also of coliform bacteria (52.0 % above 5×10^4 cfu/ml) and *E. coli* (27.0 % above 5×10^4 cfu/ml). Other bacteria isolated were coagulase-positive *Staphylococci* (34 % above 1×10^3 cfu/ml), *Bacillus cereus* (present in 35.2 %) and H₂S-reducing *Clostridia* (present in 11.2 %). *Salmonella* spp. were isolated in three samples (1.5 %) and *Listeria* spp. in only one sample (0.5 %).

Pasteurization reduced considerably the bacterial load. Analysis of samples of pasteurized milk (n=64) proved the reduction of mesophilic bacteria from average values of 107 to 104 cfu/ml, the number of coliform bacteria were reduced from average values of 105 to 102 cfu/ml, *E. coli* from 102 to 101 cfu/ml and coagulase-positive *Staphylococci* spp. from 102 to 101 cfu/ml. *Salmonella* spp. and *Listeria* spp. were not present in pasteurised milk. But *Bacillus cereus* and H₂S-reducing *Clostridia* spp. were still isolated from 50 % resp. 7.5 % of the pasteurized milk samples.

Small scale local pasteurisation units contributed significantly to secure regular income for dairy farmers through the production of value-added milk products.

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Keywords: Milk hygiene, pasteurisation, Senegal

Implications of Open-Sun Drying and Visqueen-Covered and Polyethylene-Covered Solar-Drying Technology on Fruit and Vegetable Vitamins A and C Content

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Vitamins A and C are essential nutrients in man and animals. Annually, 250,000–500,000 children worldwide become blind due to vitamin A deficiency. This deficiency approximates to 54 % in Uganda. Vegetables and fruits are the main source of vitamins A and C. However, their high (30–40 %) post harvest loss and fluctuating seasonal abundance results into economic and nutritional loss. Appropriate methods of fruit and vegetable processing and preservation to bridge seasonal gaps in nutrient supply are therefore required. The Uganda government promotes solar drying as a cheap and affordable alternative and both traditional open-sun drying and improved solar dryers are used. However, the use of later as opposed to open sun drying is relatively new and studies on the likely nutritional implications of these technologies are lacking.

This study investigated the effects of three drying methods (open sun drying, visqueen-covered solar dryer and polyethylene-covered solar dryer) on vitamins A and C content of fruits and vegetables using edible portions of mango fruit (*Mangifera indica*) and cowpea leaves (*Vigna unguiculata*). Commercial samples were analysed for vitamin C by titrimetry and b-carotene by spectrophotometry at 450 nm. Differences in vitamin retention and loss associated with the three drying methods were assessed by analysis of variance and least significant difference (LSD) at $p < 0.05$. All drying methods caused significant ($p < 0.05$) loss of vitamin C, with open sun-drying method causing the most (82–86 %) followed by polyethylene-covered solar dryer (66–82 %) and the visqueen-covered solar dryer (53–76 %) the least. The b-carotene loss was greatest with open sun drying (53–94 %) followed by polyethylene-covered solar dryer (34–84 %) and lowest with the visqueen-covered dryer (24–73 %). Blanched cowpea leaves retained more b-carotene than unblanched forms by 10–20 %. However, the blanched lost more vitamin C (5–10 %) than the unblanched cowpeas leaves. These results show that the three solar drying methods cause significant loss of vitamins A and C in dried fruits and vegetables. However, open sun drying causes the most and the visqueen-covered solar dryer the least, making the later a probable better drying technology for fruit and vegetable preservation.

Keywords: Drying methods, post harvest treatment, vitamin A, vitamin C

Prospects of *Moringa oleifera* as a Feed Resource in the West African Mixed Farming System

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Well known as a component of Senegambian foods, *Moringa oleifera* has been used for many purposes for a very long time although without any systematic mode of cultivation and conservation. Due to its high yield potential and excellent nutritive composition, this plant rightly deserves all the attention as it undergoes evaluation as a feed supplement for ruminant livestock. The integration of *Moringa* in the feeding system will significantly contribute to the reduction of feed protein constraints. The characterisation and evaluation of *Moringa* becomes justifiable as a logical development towards its integration into the animal feeding systems.

Emerging results on nutrient compositions and biomass yields on-station on the quantitative evaluation of *Moringa* has shown considerable potential as a good quality protein supplement for livestock. It also has a capability of producing up to 20 tonnes DM of utilisable biomass in a growing cycle of 50 days on-station. Young *Moringa* twigs spaced at 20 × 20 cm planting density were harvested 50 days after planting by cutting with a machete to a height of 20–35 cm above ground. Representative samples of air-dried materials were analysed for dry matter, nitrogen, neutral detergent fibre, digestibility and rumen gas production on dry matter basis. Using the Hohenheim Gas Test and in vivo methods, digestibility parameters of groundnut hay supplemented with *Moringa* were assessed. The digestibility coefficient of groundnut hay was significantly improved following supplementation with *Moringa* suggesting an ameliorated rumen function. Preliminary results in both N'Dama and its cross with the Jersey breed show that in vivo digestibility of groundnut hay was significantly improved from 50 % in unsupplemented diets to more than 60 % when total dry matter intake consisted of up to 20 % *Moringa* on DM basis.

These qualities of *Moringa* strengthens its wider role and underscores the benefits of its systematic integration into the crop-agroforestry-livestock mixed farming system of West Africa especially where high producing livestock such as crossbred milking animals are involved.

Keywords: *Moringa oleifera*, ruminant nutrition, West Africa

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Soil Crusting and Sealing in the Andean Hillsides of Colombia and its Impact on Water Infiltration

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Soil erosion is a major global problem. Apart from climatic reasons, major causes are inappropriate land-use and improper fertilizer management as well as socio-economic constraints. In order to acquire a basic knowledge of soil degradation and to design sustainable cropping systems in the tropics, efforts have been made to investigate soil crusting and sealing as primary factors of soil deterioration. Both phenomena have a negative impact on water infiltration, reduce air permeability and seedlings emergence. Due to the reduction of water infiltration, the surface run-off increases and in consequence enhances soil erosion. The aim of this research was to investigate negative impact of soil crusting on infiltration. Field trials in an Andean hillside environment with cassava-based cropping systems were established in the southwest of Colombia on an amorphous, isohyperthermic oxic Dystrypept (Inceptisol). Measurements have been carried out using a penetrometer to measure penetration resistance and a mini-rain-simulator to investigate water infiltration. Two general types of soil crusts were found. The first emerged due to the destructive impact of raindrops on insufficiently covered soil surfaces and weak superficial soil aggregates. The second type developed through chemical dispersion of clays during the raining season and following forming-up of more pronounced soil crusts and seals during the dry seasons. Andean Inceptisols normally have a good soil structure. Nevertheless, it was found out that chicken manure significantly increased penetration resistance due to soil crusting in the dry season (from 8.3 kg cm^{-2} in a mineral fertilized cassava intensive tillage treatment to 25.3 kg cm^{-2} in a cassava treatment manured with 8 t ha^{-1} chicken manure). Results from field trials showed a destructive impact of chicken manure on soil structure and a reduction of water infiltration. Furthermore, conservation tillage systems like minimum tillage and improved fallow cropping systems improved final water infiltration (76.6 mm h^{-1} in cassava minimum tillage treatment compared to 42.2 mm h^{-1} in cassava 8 t ha^{-1} chicken manure treatment) and consequently reduced surface run-off. This substantiates the hypothesis that inappropriate fertilizer management and unsustainable cropping systems are the key factors of structural deterioration on Inceptisols in the Andes of Colombia.

Keywords: Chicken manure, inceptisols, infiltration, soil erosion, tillage system

New Method for the Mathematical Determination of Drying Rates of Fig Fruits Depending on Empirical Data under Conditions Suiting Solar Drying

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Thin-layer drying rates of fig fruits were determined experimentally under different conditions of the drying air temperature, relative humidity and velocity, and under different initial moisture content of the fruits. Twenty-four drying tests were run by an experimental dryer, locally designed and fabricated for thin-layer drying. The results showed that the drying air temperature, the fig fruits initial and final moisture content had the greatest effect on the drying rate of fig fruits, followed by the drying air relative humidity. Air velocity had the smallest effect.

The objectives of this research work could be summarized as: expressing the loss of moisture during the drying process of the fruit or the vegetable, as a function of the affecting factors of the drying process, determination of the fruit or the vegetable drying rate as a function of all the affecting factors, determination of the needed time through each stage of the drying process, and how to benefit from the findings of this research work.

This work was planned for mathematically expressing the loss in fig fruits moisture along the drying process as a function of the affecting factors by applying multiple linear regression analysis. The derived mathematical equations which relate the results of the drying process with the affecting factors could be used in the determination of the instantaneous moisture content of the fruits at successive time intervals. These equations are especially useful for solar drying under which the drying air properties are under continuous changes along the time of the day and along the days of the year. The derived mathematical equations covered all the stages of the drying process, i.e, the stage of the primary increasing drying rate, the stage of the constant drying rate and the stage of the falling drying rate.

Keywords: Drying, drying rate, fig fruit and mathematical, thin layer

The Effect of *Azolla* on N Use Efficiency in Rice-Wheat Rotations of Nepal

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The efficiency of applied urea -N is very low in farmers' fields of Nepal. High temperatures combined with high floodwater pH during the day (effect of the activity of the photosynthetic aquatic biomass) favor the losses of newly applied mineral fertilizer N by the process of ammonia volatilization, particularly during the early growth stages of lowland rice. Previous studies under controlled conditions in pots as well as under field conditions in the Philippines could show that a dense cover of the floodwater by the floating fern *Azolla* can reduce NH₃ losses by buffering diurnal variations in floodwater chemistry and by direct N absorption. While increasing the role of *Azolla* in reducing ammonia volatilization and N sequestration and N use efficiency in a rice (*Oryza sativa* L.) — wheat (*Triticum aestivum* L.) cropping system of Nepal was investigated in farmers' fields between 2001 and 2002. Five urea N rates (0 – 30 – 60 – 90 – 120 kg split-applied N ha⁻¹), sole *Azolla* (5 t ha⁻¹) and *Azolla* plus urea (60 kg N ha⁻¹) application to lowland rice were compared and residual effects were evaluated in the subsequent wheat crop. *Azolla* coverage decreased the floodwater pH by 1.8 units and the ammonia partial pressure by 0.336 Pa, thus reducing the potential for ammonia volatilization from the flooded rice field after urea application. Consequently, the application of *Azolla* in combination with urea increased rice yields by 10–14 % above the sole urea treatment. The ¹⁵N-recovery of the first urea application in the soil-plant system was less than 40 % and did not differ between *Azolla* and sole urea treatments. However, ¹⁵N-recovery for the second dose of urea (topdressing) was significantly higher with *Azolla* (90 %) than in sole urea treatments (75 %). While no significant residual effects on the subsequent crop of wheat were observed, *Azolla* contributed to the reduction of ammonia volatilization and increased the efficiency of applied urea N in lowland rice.

Keywords: N-recovery, ¹⁵N, *Oryza sativa*, *Triticum aestivum*, urea

Crop-Livestock Integration and Food Security among Resource-Poor Rural Farmers in North-Western Nigeria — An Empirical Study from Zamfara State

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Resource-poor rural farmers in north western Nigeria work for multiple goals such as family food security, increased revenues, and production expansion. The most important of these goals to these farmers is the family food security. One major factor that obstructs the attainment of this goal is the maintenance of soils fertility. However, farmers in the study area are generally poor, and unable to afford conventional fertilizers and have thus embraced the local alternative mean of integrating crop and livestock system to enhance the fertility management of their soils. Various forms of integration have been identified based on local peculiarities and practises. One form of integration is a situation in which a farmer combines cropping and animal husbandry under same management while in the other, a farmer involved in cropping exchanges produce with other that specialised in animal husbandry. The first is referred to as closed integration while the second is referred to as segregated integration. This paper describes in detail crop-livestock integration, and shows its capacity to enhance family food security among farmers in the study area. A nine months field survey was conducted in Zamfara reserve in Nigeria from December 2001 to August 2002. Information was collected from the farmers practising various types of integration and those not involved in integration using household level approach on socio-demographic characteristics, resource endowment, production inputs and outputs. Farm budgeting technique was used to determine net farm revenues of farmers. Quantitative analysis of produce consumed and produce sold were also determined. First results shows that farmers with closed integration had average yields of 1953 kg/ha translating to a net income of N 66,262 while farmers with segregated integration had average yields of 1563 kg/ha translating to a net income of N 44,865. On the other hand, farmers that were not involved in integration had the least average yields of 1150 kg/ha translating to a net income of N 22,684. These preliminary results have shown clearly that farmers involved in integration are more food secured, more able to expand outputs and consequently make better returns from their farms.

Keywords: Crop-livestock integration, food security, resource-poor farmers, soil fertility management

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Does Diversification of Smallholder's Animal Production Systems Contribute to Sustainable Development in Northern Patagonia, Argentina?

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In Río Negro Province, Northern Patagonia, more than 4,000 producers practice extensive small livestock farming. Approximately 80 % are smallholders, mainly fiber production oriented. The production system faces an environmental and socio-economic crisis due to high production costs, grassland degradation and widespread poverty. Ecological sustainability, economic feasibility and socio-political acceptability are the three dimensions of sustainable development. The main objective of this study is to evaluate the impact of diversification on the socio-economics and range condition of the farms, under the following hypothesis: "An increasing degree of product diversification increases the incomes without increase grassland degradation in smallholder livestock systems of Southern Río Negro".

Field studies will be conducted between December 2002 and April 2004. An exploratory survey is currently implemented to investigate effects of natural and socio-economics factors on the development of livestock systems. Standardized interviews will be applied on a representative sample of 100 farms involving diversified and non-diversified farms. Through an economic analysis at farm level, the impact of the different degrees of diversification on farm household income will be evaluated. The impact of diversification on range condition will be analyzed.

The following results are expected:

- Contribution of each activity to the whole farm will explain the farmer rationale
- Detection of resource losses will lead to recommendations for system improvement
- Economic and ecological analysis will provide information on the potential productivity in the region in diversified production systems
- Formulation of adequate policies.

Keywords: Diversification, Patagonia, smallholder production systems, wool production

Waste Resource Management on a Regional Level: Can Urban Wastes Be Used as Resources in Rural Areas? — A Comparative Case Study in Colombia and Tanzania

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By the year 2010 around half of the population of the so-called developing countries will live in urban areas. Here, on the one hand, agricultural land is being exploited to nourish an ever increasing urban population, but management of household organic waste and faeces is often only being solved rudimentary. On the other hand, organic wastes, which are mostly dumped, could be reintegrated into the nutrient cycle. Colombia and Tanzania dispose of a high potential for waste recycling as here household waste consists of a high portion of organic components (approximately 70–80 %) which could be composted. A carbon and nutrient cycle between urban and rural areas could contribute to ecological and economic sustainability through recycling organic waste materials into food production: Through application of composted organic wastes not only a humus carrier for organic poor tropical soils could be supplied, also substantial costs for inorganic fertilisers could be reduced.

The poster will describe an upcoming project, which is to contribute to the growing interest of integrating soil fertility problems and organic waste treatment. The project integrates knowledge from natural and social sciences. In a first step, we investigate the fluxes of soil organic matter (SOM) as well as knowledge on organic waste management in an urban-rural context on a regional level. Hereby, the method of material flux analysis will be applied to a watershed in Colombia and Tanzania. Possible contributions of a whole rural-urban region for preserving SOM in the rural areas are to be modelled. Based on these estimations potentials for carbon cycling between rural and urban areas shall be derived.

One major issue of the utilization of processed urban wastes in rural areas is the acceptance. Thus, the project will focus on knowledge dissemination processes regarding waste management between the different actors involved to be modelled in so-called knowledge-flow diagrams. Therefore, problem perception in rural and urban areas as well scenarios are to be developed together with the local actors in a participative process. By this, the project contributes to transdisciplinary research.

Keywords: Acceptance, Colombia, composting, knowledge dissemination, material flux analysis, organic waste management, soil fertility, Tanzania, transdisciplinary approaches

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The Role of Organic Farming to the Improvement of Sustainable Agricultural Production in Southeast Sulawesi, Indonesia

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Southeast Sulawesi, which consists of the five provinces in Sulawesi Island, is located in the eastern part of Indonesia where more than 80 % of the population practices dry-land agricultural system. Red yellow podzolic soils are predominant soil type of the region characterized by low soil fertility with low organic matter, low soil pH, shallow top soil, low water holding capacity, low cation exchange capacity and low macro nutrients like N, P and K. Intensification, extensification, rehabilitation and diversification programs are currently among many efforts that have been implemented in order to increase agricultural crop production, but these have not yet been optimally satisfied due to the rapidly increasing population. Therefore, the need to seek out the suitable approach is compulsory. The application of organic farming has becoming urgently not only to enhance agricultural production by the utilization of organic biomass as sources of nutrients but also to preserve natural environment for soil and water conservation. The objectives of this paper are to describe the role of organic farming and potential use of biomass accumulated into plant tissues as organic mulch and nutrients derived from various plant species, to screen and examine selected indigenous species which are able to accelerate the accumulation of biomass during fallow. Recent study on the potential yield of natural vegetation biomass accumulated into plant tissues as sources of mulch and nutrients is exemplified. The effects of sole organic mulch or combined on tested crops, like maize, soybean, peanut that are planted either in monoculture or in multiple cropping system, are discussed. The influence of secondary vegetation biomass either utilized as mulch or incorporated into the soil on the growth of maize is also tested. In fallow management, enrichment planting using fast growing plant legumes or non-legumes and nitrogen-fixing trees and or cover crops is figured out. Based on various test crops conducted, it shows that the role of organic farming significantly improve the physical, chemical and biological soil properties and in turn to increase agricultural production sustainably.

Keywords: Cover crops, enrichment fallow, Indonesia, organic mulch, sustainability

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Contributions of Trees Dispersed in Pastures to Livestock Farms in Costa Rica

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Livestock production systems and the tree component within them were characterised in La Fortuna, San Carlos, Costa Rica. Three types of production systems were observed: mixed (dairy and agriculture), dairy, and dual purpose (milk and meat). Milk productivity (kg ha^{-1}) was highest for dairy farms. The area of pasture with trees was greater in dual purpose systems (74 % of total area), predominantly timber trees. The timber tree species laurel (*Cordia alliodora*) was predominant in the pastures, although its density was low (11 trees ha^{-1}). In specialised milk systems, a significantly high density of shade trees was found compared to the other systems, protecting exotic animal breeds from direct sun. No significant differences were observed between the systems in live fence tree species and the fence lengths covered per ha of pasture. The dual purpose system presented the greatest abundance of laurel with small diameters, assuring a sustainable natural regeneration of this species, and the greatest merchantable volume of laurel ($2.21 \text{ m}^3 \text{ ha}^{-1}$). The greater abundance of laurel in the dual purpose system may be related to the fact that these livestock farmers try to reduce risk by diversifying farm production. The highest net present value (US\$ 256.18 ha^{-1}) was found in the dual purpose systems. The average income from milk production in all three systems contributed the most to the total gross income (49.8 %), while the average income from wood only made a small contribution (1.02 %). In the future the tree component could play a more important role in the cattle production systems of the region.

Keywords: Cattle farms, *Cordia alliodora*, financial viability, La Fortuna, San Carlos, shade trees, timber trees

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The Potential of Agroforestry for the Rehabilitation of Degraded Land in Central Sulawesi, Indonesia

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Between 1990 and 2000, the forest area in Indonesia decreased by more than 1.3 million ha per year, primarily due to conversion of natural forests into other forms of land-use, like agriculture and tree plantations. Indonesia, however, also has vast expanses of unproductive land such as degraded secondary forests and *Imperata* grasslands, rehabilitation of which could reduce the pressure on natural forests. In Central Sulawesi, farmers have traditionally used a system of enrichment planting to establish forest gardens. In these forest gardens, a wide variety of crops is cultivated under a cover of mixed useful tree species.

In this paper, three forest gardens in different parts of Central Sulawesi are compared with regard to their structure, species composition, diversity and their importance for rural livelihoods. The research methods included stand inventories, interviews with farmers and participatory observation. The paper describes the different systems for the establishment and development of forest gardens, determined by the previous form of land-cover. With up to 120 species of useful plants per hectare, forest gardens not only have a high species diversity, but they also provide a wide variety of products for use in the household or to sell for cash income. In the investigated households, up to 77 % of the cash income is generated from forest gardens, a number that underlines the important role of this land-use system for the improvement of rural livelihoods.

In Central Sulawesi, traditional forest gardens are a well established, sustainable and economically successful land-use system that requires low input, and can be flexibly adapted to different basic conditions. With slight modifications and local adaptations, this agroforestry system could be a model for the rehabilitation of degraded areas in other parts of Southeast Asia.

Keywords: Agroforestry, forest gardens, sustainable land use

Vascular Plant Diversity of a Philippine Rainforest Fragment as a Potential for Local Land Rehabilitation

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The global dimension of land degradation and its socio-economic consequences show that land rehabilitation is one of the most challenging tasks of our time. Although biodiversity issues are an important topic in reforestation as well as in agroforestry the species used are still few and mostly exotic.

The Philippines belong to the mega-diversity hotspots, but are at the same time one of the most seriously depleted tropical rain forest countries. The foothills of Mt. Panagasugan (1156 m) on the island of Leyte are exceptional for their rugged relief still harbors patches of lowland rain forest. The objective of this study was to assess their vascular plant species diversity and to evaluate the potential as seed bank for an alternative land rehabilitation concept ('rain-forestation').

Within 49 plots (100 m² each) 685 plant taxa have been encountered. That is about 8 % of the Philippine total. All five Philippine dipterocarp forest types as well as the Molave type were represented by typical tree species. 18 species of *Dipterocarpaceae* (Philippine mahogany) could be found. Legume species (4 spp.) — like rose wood (*Pterocarpus indicus*), or ebony (*Diospyros* spp.) produce valuable high grade timber. Other species are typical fruit trees (e.g. *Nephelium* spp.) or may be used for river bank stabilization (e.g. *Duabanga moluccana*, or *Terminalia microcarpa*). Besides trees other plant groups provide marketable products, like rattan (14 species) or some herbs which are searched for as medicinal plants (e.g. *Chloranthus erectus*).

The area harbors a pool of species providing a variety of goods and services and thus principally suited for land rehabilitation. The main obstacle to a successful cultivation will be the lack of ecological information, especially concerning site requirements and reproduction.

Keywords: Land rehabilitation, native species, seed source, reforestation

Towards Rehabilitation of Barren Hills — How Does Fallow Vegetation Reflect Land Degradation Status?

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Breakdown of local shifting cultivation land management systems in the highlands of Northern Vietnam, triggered by high population pressure, results in alarming spread of degraded, low-productivity land on former forest land. Despite an urge for reclamation of these degraded “barren hills” scientific basis for assessing type and severity of land degradation is lacking. An explorative interdisciplinary study on one representative land use gradient hillside was undertaken to provide preliminary information on spontaneous vegetation, soil and related land use histories. A survey of vegetation physiognomy documented floristic composition, stratification and abundance-dominance indices; forests were quantitatively assessed by point-centered quarter method. Soil type and the major physical and chemical constraints were identified. Participatory rural appraisal tools were employed to obtain land use information. Land degradation is reflected in forest degradation, overgrazing, soil erosion and invasion of non-native weeds. The total of 352 species belonging to 244 genera of 80 families describe gradual vegetation transition in a regressive succession of climax laurel forest (dominated by *Fagaceae*, *Lauraceae* and *Magnoliaceae*) towards degraded pasture of *Paspalum conjugatum*, *Axonopus compressus* and *Chrysopogon aciculatus*. Reconstruction of successional interdependencies of encountered physiognomic units as a function of land management has been proposed. Typical edificatory species and complexes of particular fallow vegetation seral stages correspond to use length of a plot, which is related to the maintenance of adjacent forest. Floristic composition, as a measure of deviation from initial forest community, is used by farmers to estimate the required fallow regeneration time till the next cropping. Concomitant soil properties, however, seem to be correlated to the structure (density) of vegetation: improved soil characteristics occur with denser vegetation cover of previous fallow and contribute to denser one of a following regrowth cycle. This apparently regular pattern of disturbance after forest disappearance is principally determined by intensity of buffalo grazing; it accounts for different physiognomies of plots of the same fallow age.

Analysis of soil and vegetation relations on fallow lands can provide insight into natural regeneration potentials and constraints, thus constituting the basis for subsequent formulation of land rehabilitation strategies.

Keywords: Land use history, succession, vegetation physiognomy

Linking Agro-Forestry with Smallholder Livestock Production — A strategy for Participatory Forest Management with Communities in the Central River Division of The Gambia

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The Central River Division Forestry project (CRDFPII) in the second 5-year phase aims to support the Forestry Department (FD) to implement the Gambian Forest Management Concept (GFMC), whose main thrust is the involvement of communities in sustainable forest management for present and future generations. During the first half of the phase I of the project, a rather conventional approach was adopted for the management of Forest Parks (FP). Exploitation for grazing, fuel wood collection and other forest products were allowed but management was still with the FD, without the direct involvement of the livestock sector although livestock population in CRD constitute about 40 % of the national cattle population. Consequently, illegal exploitation was rampant, bush fires were on the increase and forest degradation continued unabated. These experiences led to the initiative for the involvement of the Livestock Department, the International Trypanotolerance Centre (ITC) and other stakeholders. The purpose of this partnership is to develop synergies between forestry and livestock production and to use livestock as one of the entry points for FP management. A three-tier activity level was proposed: interventions within and outside the forests, and sociological measures to improve communal attitude towards forestry management. All activities were fully supported by the Gambian Forest Communication Concept (GFCC). Participatory tools were the vehicles used to develop and implement activities. There was a great improvement in community participation in sustainable forest management, which translated into signing joint management agreement with over 40 communities, establishment of 8,000 fodder trees around forest borders, and degraded or encroached forest parks. Fire management was considerably improved. The incidence of bush fires reduced from between 70 % to 85 % annual figures to less than 10 % during the current year. The partnership also saw the emergence of communal groups such as forest committees and Livestock Owners Associations (LOA). Although livestock integration is a *viable option* for sustainable forest management, there is need for controlled grazing practices.

Keywords: Forest park management, fodder trees, green belt, sensitisation, Gambia

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***Flemingia macrophylla* — A Tropical Shrub Legume for Dry Season Supplementation — Forage Quality and Dry Matter Production**

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Flemingia macrophylla is a drought-tolerant shrub legume well adapted to low-fertility, acid soils of the sub-humid and humid tropics. It is especially suited to low-input smallholder production systems. The species enhances soil fertility and can be used for a number of purposes such as dry season forage supplementation, live soil cover or mulch, erosion barrier hedges, shade-providing shrubs in young coffee and cocoa plantations, firewood, and others. Its particular advantages are: vigor, leafiness, wide range of soil adaptation including very acid, low-fertility soils, drought resistance, excellent coppicing capacity and regrowth after cutting, and slow leaf decomposition. Few genotypes are currently utilized. Their main limitation is low nutritive value in terms of digestibility because of high tannin content combined with very low palatability to cattle. The aim of the study was to assess the genetic diversity within the available germplasm collection, and to identify materials with superior quality. Evaluations on plant characteristics related to forage quality (digestibility, palatability, nitrogen, fiber and tannin content) were carried out. Results of the morphological and agronomic evaluations indicate considerable variation in the collection. *In vitro*-dry matter digestibility of 8-week old foliage varied from 33 to 53 % and crude protein content from 15 to 24 %. Several accessions with superior DM yield and better digestibility than the control variety CIAT 17403 were identified. More detailed analysis of two subsets showed that accessions with higher feed quality in terms of digestibility and DM production had lower tannin and fiber contents than low-quality accessions. Morphological studies clearly revealed four different growth types. Agronomically promising accessions were either of the erect or semi-erect type. Based on the results of this study, the five agronomically most promising accessions were identified. Further research is needed to optimize propagation, as seed production of these accessions is very low.

Keywords: Digestibility, *Flemingia macrophylla*, forage legumes, forage quality, tropics

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Natural Resource Use and Living Standard Generation by Indigenous Communities in Comparison to Immigrant Settlements — The Case of Bananal Island, Tocantins, Brazil

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Brazil is home to 218 different indigenous nations with a total population of 350.000 people, of whom 60 % live in the Amazonian area. These ethnic groups are of pre-Columbian origin or ascendance and show cultural characteristics that distinguish them from other parts of the national society. Nowadays, their traditional dwelling areas in tropical rainforests are under increasing pressure from the use of the natural resources by various actors with conflicting interests. Indigenous groups depend on the use of natural resources not only with regard to basic food supply but also on the social and cultural level, where the respect towards forest entities has a spiritual dimension. The contact with non-indigenous settlers, who move into areas that were exclusively inhabited by Indians before, brings changes that may even end up in an irreversible acculturation. The resulting recognition of the value of natural resources for the immigrants frequently by indigenous communities and individuals frequently starts an unfair trade with forest goods. Simultaneously, spiritual respect declines as the interest in profit from this trade increases. The evolution of this process may transform indigenous communities into peripheral smallholders due to the overuse of natural resources and engender impoverishment of their societies.

Holistic analyses of indigenous households and farming systems of immigrants are required to understand the dynamics of this process and to identify agreeable solutions for the involved actors. The application of a respective approach on the Bananal Island in the western part of Brazils Tocantins yielded indications on the differences in objectives, perception of value of different forest goods and living standard between the indigenous population in recently recognized indigenous territories and settlers who were transferred out of these territories into adjacent areas.

Keywords: Farming system, forest goods, indigenous, living standard, smallholders

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Potential of Vetiver (*Vetiveria zizanioides*) for the Use in Phytoremediation of Petroleum Hydrocarbon-Contaminated Soils in Venezuela

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Venezuela is one of the largest oil-producers in the world. For the rehabilitation of oil-contaminated sites, engineering techniques are conventionally used but the interest in biological-based methods is growing. Phytoremediation represents a promising alternative technology. It is based on the use of plants and their associated microorganisms to remove or contain organic or inorganic contaminants present in soil and water.

Within the research on phytoremediation in Intevep (Research and Technological Support Centre of the Venezuelan oil company PDVSA) a greenhouse experiment was conducted. Vetiver grass (*Vetiveria zizanioides* (L.) NASH) was chosen as the experimental plant. The 6-month study aimed to determine the tolerance of vetiver to a heavy crude oil (Boscán) in soil. Additionally, the potential for stimulating biodegradation of petroleum hydrocarbons was tested. Plant growth and soil parameters between different treatments. Vetiver transplants suffered under the influence of crude oil. However, most of them demonstrated the ability of asexual reproduction. After 6 months, the tiller production rate was higher in contaminated than in uncontaminated soil. Despite significantly reduced biomass and heights, the tillers did not exhibit signs of toxicity on their shoots in the presence of contaminants but their root surface areas were reduced. First, growth was higher in the medium (220 N/kg, 110 mg P/kg, 110 mg K/kg) than in the high fertilizer treatment (300 mg N/kg, 150 mg P/kg, 150 mg K/kg) of contaminated soil but in the course of the experiment, plant growth achieved a similar development level. Vetiver was found to be tolerant concerning the toxic effects of crude oil in soil. As to the degradation of total oil and grease in soil, no significant increase in biodegradation in the presence of vetiver was detected. Thus, the species was deemed to be unsuitable for facilitating biodegradation of crude oil in soil. However, vetiver is a beneficial plant in soil and water conservation practice. Promising uses of the species on petroleum-contaminated sites in Venezuela are for amelioration of soils, as “organic pumps” and for erosion control.

Keywords: Biodegradation, crude oil, petroleum hydrocarbons, phytoremediation, Venezuela, vetiver

Performance of Pastures Enriched with Secondary Vegetation or Forage Legumes as Alternatives to Traditionally Managed Grass Pastures in Northeastern Pará, Brazil

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The integration of cattle pastures into the traditional slash-and-burn cycle in the humid tropics, where secondary vegetation ('capoeira') plays an important role to recuperate the soil and maintain biodiversity, might be an option to avoid pasture degradation. Two alternatives were tested against a traditional *Brachiaria humidicola* pasture (PT), namely a *B. humidicola* pasture allowing a controlled regrowth of capoeira (PC) and another one enriched with the legumes *Cratylia argentea*, *Chamaecrista rotundifolia* var. *grandiflora* and *Arachis pintoi* (PL). Nine experimental plots of 0.34 ha each were established on a smallholder crop field in the municipality of Igarapé-Açu (47°30'W / 1°2'S). Forage availability was measured at the beginning of a grazing period and the botanical composition of the diet of the grazing steers was estimated by microhistological analysis of faeces at the end. During the first experimental phase (22/3/2000 – 1/3/2001) the forage availability did not differ between the treatments grazed at a stocking rate of 667 kg ha⁻¹, but there were significant differences in the diet. On PT the highest proportion of forage grass and on PC the highest proportion of *Capoeira* species was found in the diet. The daily weight gains reached 614, 552 and 647 g on PC, PL and PT, respectively but did not differ significantly. During the second phase (7/6/2001 – 8/3/2002) the stocking rate averaged 553 kg ha⁻¹. The forage availability was highest on PT but on all plots much lower than in the first period due to a spittlebug attack and lower rainfall. The daily weight gains of 52, -62 and 276 g on PC, PL and PT, respectively, were significantly lower than in the first period and significantly higher on PT than on PC and PL. The low performance on PL and PC in the second phase was apparently caused by the stocking rate exceeding the available forage. In consequence, on PL seedlings of the little palatable *C. rotundifolia* dominated the plots and the percentage of legumes in the diet dropped from 16 to 13%. Thus, the alternative pastures proved more sensitive to the inadequate stocking rate than PT.

Keywords: Brazil, forage availability, secondary vegetation

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Management of Laurel (*Cordia alliodora*) within Agroforestry System in the Canton Loreto, Ecuador

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Second forests become widespread due to socioeconomic reasons especially for ever growing population in the tropical region of the world. The management of secondary forest has become a very important aspect of scientific investigation in the region. The potential value of this resource, which covers extensive areas in the Ecuadorian Amazon Region, is not always recognized. A species of great potential in the secondary forest and in abandoned agricultural lands is *Cordia alliodora*, which is known as Laurel in the Spanish language. Laurel regenerates naturally and thus production costs are potentially low. Growth is rapid, the wood qualities meet the requirements of the industry and the species seems to be suitable for agroforestry systems. Viable agroforestry systems in terms of social and economic aspects of the local communities is necessary to check extent of the secondary forests and to help conserve the primary forests. The objective of this contribution is to present first results of a growth and regeneration study of *Cordia alliodora* within an agroforestry experiment in the community of Wamaní, Ecuador. Necessary tree growth parameters were collected and analyzed. Results include information about the response of nine one quart ha plots to different thinning intensities, including height growth, individual tree volume equations and diameter distributions. It is recommended that on similar sites in the region one should take advantage of the natural regeneration of *Cordia alliodora* in the first years in order to establish future agroforestry systems leaving between 175 and 225 trees per ha.

Keywords: Agroforestry system, height growth, tree volume

Growth, Gas Exchange and Ion Uptake of *Tamarindus indica* Seedlings under Salt Stress

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In many parts of Sudan the degradation of agricultural land is becoming a more and more severe problem. One of the main factors is soil salinity. Tamarind (*Tamarindus indica*) is a native tree species within the savannah belt of Sudan. The tree is very well known and its fruits are intensively used by the rural population. Previous investigations indicate that tamarind is more or less salt tolerant.

To investigate the response of *T. indica* seedlings to salt stress an experiment was conducted in the greenhouse of the Department of Fruit Science in Berlin. Four-week old seedlings were grown in sand culture and treated with different salt solutions. Treatments were prepared by adding 0, 20, 40, 60 and 80 mM NaCl to the nutrient solution. 50 seedlings were put under stress for a time of 20 weeks under controlled environmental conditions (n = 10).

Plant growth was affected by the salt treatments. In the 40 mM NaCl variant, the reduction of fresh and dry weight was less than 50 % after the 20 weeks in comparison to control plants. Foliar injuries (necrosis) did not appear within all salt treatments. Only leaf yellowing were frequently observed in the 60 and 80 mM treatments. However, with increasing salinity levels, leaf moisture content increased, indicating a salt-induced leaf succulence. Increased NaCl salinity decreased the photosynthetic rate as a function of time. After 20 weeks, plants treated with 20, 40, 60 or 80 mM NaCl exhibited a 34 %, 50 %, 75 % and 91 % drop in photosynthesis rate compared to the control. The decrease in photosynthesis was probably due to a diminished stomatal conductance and a degradation of chlorophyll content. Chlorophyll content of leaves at higher salinity levels was lower than at lower salinity levels. Raising NaCl levels in the irrigation solution increased Na⁺ and Cl⁻ concentrations in the plant tissue. Leaf Cl⁻ concentration was much higher than Na⁺ concentration.

The results have shown that *Tamarindus indica* seedlings tolerated a salinity level of 40 mM NaCl. This indicates that in the seedlings stage tamarind is a fairly salt tolerant tree species compared to other fruit trees.

Keywords: Physiology, salinity, tamarind, *Tamarindus indica*

Spatial Continuity in a Multicohortal Ecosystem in the Natural Protected Area Cerro Potosí, Nuevo León, México

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The Dynamics in a Forest express how ecosystem composition evolves in time and space. In forest stands, variations in any of the elements originates a dynamic expression at spatial level: floristic association, number of individuals, the strata structure, and the age categories, at this point the different age phases of a stand, express both temporal dynamics and the temporal continuity of the ecosystem.

The goal of the study was to document the spatial continuity and growth dynamics of *Pinus culminicola*, along elevational gradient and differences in the growing conditions. Such information helps to determinate the floristic association and its respective grade of association with others species present in the area. The study area is situated in Nuevo León, starting at 3100 m. The permanent plots samples were located along three different elevational gradients in which three permanent plots were also established.

According the analysis of the collected information, we found that the elevational factor is the variable that affects basically the species distribution. This variable affects the number individuals between the species, *P. culminicola* and *P. hartwegii*. The continuity from this ecosystem can be analyzed using the regenerational patterns of *P. culminicola*. Using coverage as dependent variable to modelling regeneration, the regeneration is expressed according the next function: using this function we apply a series of mathematical models trying to adjust the best tendency. Using the coverage, the capacity of regeneration in this area is low in the gradient nr 1 (3100 m) and then exist an increment in the second (3300 m) and in the last gradient (3500 m) exists a decrease in the regeneration capacity. Considering this type of analyzes concerning the population structure of the community, it is an appropriate method to describe the vegetational dynamic of the species present in Cerro Potosi. This is very important, because this is an endemic species from the subalpine areas from Northeast Mexico, which requires precise methods to preserve this species in the future.

Keywords: Forest dynamics, *Pinus culminicola*, spatial patterns, spatial structure

Perception of the Forest as a “Green Bank” Evolved among Rural Population in the Test Zone of Dankou, Sénégal

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Degradation of wooden resources is one of the major causes for desertification and its following increase in poverty among the rural population in Sénégal. The household energy project in Sénégal, carried out by the GTZ, aims at the conception and completion of sustainable management for domestic energy resources. Apart from providing alternative energy supplies this is achieved also by operating the 3500 ha forest test zone of Dankou in the province of Kaolack. This is executed in a participative manner together with the indigenous population of 16 villages in order to secure sustainability.

This study assessed the evolution of perception by the participating villagers over the past six years, including their judgement of both the sense and progress of the project, and their ideas, requirements, and visions for the short-term and long-term direction of the project. The method of an ethnographical analysis was applied to investigate the relationship between the rural population and the forest. The enquiry focused on key groups within the population: elderly, women, special knowledge carriers, and village representatives. The enquiry shows that initial scepticism turned once the first results of the participative cooperation started to emerge. After six years of forest management, enough naturally dead wood is extractable to satisfy the needs of the local population and beyond. Moreover, the participants witnessed additional long-term benefits of forest restoration, such as: an increase in the number of vitamin bearing fruits, medicinal plants, and animal life. The emerging products not only contribute crucially to the nutrition but are also capable of being commercialised within a system of micro-enterprises. Active contribution as well as resulting revenues enhance the population’s perception of the forest as a “green bank”. The participant’s expertise and knowledge is producing new ideas and visions that already did and further will influence future actions of the PSACD.

Keywords: Green bank, energy resources exploitation, ethnographical analysis, forest degradation, micro-enterprises, participative management, sustainable development

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Industrial Afforestation Programme with *Acacia mangium* in Tropical Savannas of Roraima, Brazil

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Tropical forests are still disappearing at an alarming rate although recent studies indicate that forest depletion is slowing down. Government supported reforestation and afforestation campaigns often failed, because (i) the local population seldom actively participated and benefited in and from the activities, (ii) government institutions often lack the managerial skills to administer diverse forestry activities, and (iii) the necessity to adhere to economical principles was not distinctive. Consequently, initiatives based on private investments should show more promising approaches, appropriate for management of large scale reforestation projects. However, reestablishment of natural forest vegetation is capital-intensive and periods until first returns can be expected usually are beyond the acceptance level of private investors.

An alternative is the establishment of forest plantations with fast growing timber species. Fibre wood and high value timber ideally can be produced simultaneously in short to medium terms. Low quality stems and wood from tending operations, both highly suited for fibre production, become already available within 3–5 years after planting. Wood for sawmilling can be produced within 12–15 years.

The afforestation project in Roraima performs the plantation approach with private investments. However, the natural savannahs (Cerrado) show harsh conditions for tree plantations. Soils are heavily compacted after years of cattle ranching, bush fires are abundant, especially during the dry season, and plant-available soil nutrients are low. However, after soil melioration, the planted trees show satisfactory performance. The first stands were planted in 1999 and meanwhile first silvicultural treatments are carried out. Inventory results show that volume increment has a high variation which clearly can be attributed to site conditions. Thus, permanent improvement measures of melioration activities need to be elaborated. Continuous feed-back of performance data combined with cost surveillance allow effective investment monitoring.

Keywords: *Acacia mangium*, afforestation, Brazil, cerrado, savannah

The Role of Plan Form of Valley-Ravine Net in the Process of Mud Flow Formation

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Seventy-five percent of all mudflow events in Armenia occur at 1800–2000 m heights. The reasons responsible for this are identified to be: 1) the large surfaces of those heights, 2) the centralisation of flow on those heights 3) the essential impact of anthropogenic factor over those heights. The mudflow formation is influenced by: 1) Local topographical particularities, 2) Geological-geomorphologic state, 3) Hydro meteorological conditions, 4) Soil-vegetation cover features, and 5) Human impact.

Republic of Armenia is a mountainous country, where on 30 000 km² the height difference constitutes 3700 m. The horizontal ruggedness over 70 % of country surface is 1–1.6 km/km² and more. The amount of talvegs range between 30–50 on 1 km².

The role of plan form of valley-ravine net in the process of mudflow formation is very decisive. For mudflow to form, a mountain relief is necessary. For the centralization of mudflow it is essential to have certain relief conditions and a plan form of valley-ravine net. There is very close relation between the form of mudflow watershed (K), the perimeter (C) and the line connecting mouth and spring (start) (D):

$$K = C/D$$

Our investigations have shown that mudflow watersheds with fan-shaped net usually have K (form coefficient) more than 2.8. In the case of plumose-type valley, net K is no greater than 2.5. In the case of transition or mixture nets, K value is ranging between 2.5–2.8.

The mudflow bed profile is another important mudflow-forming component in the case when other components have the same meaning. For the mudflow formation, the worst situation was identified to exist in southern and southern prone slopes, which are characterized with insufficient humidity, big thermal differences, scarce vegetation cover. Also, the hard component emerges here most easily. In northern aspects, mudflow events are rare due to forest, meadow and other intensive vegetation cover.

Keywords: Fan-shade net, mudflow, plan form of valley-ravine net, plumose-type net

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The Impact of Out-Migration on the Rural Culture — The Case of El Parque Chaqueño Argentina

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This work is focused on the transformation of rural culture by means of out-migration. It comprises the analysis of the cultural transformation of the rural place as well as the different strategies of the remaining communities in trying to maintain their rural identity. The research has been undertaken in six communities found in the arid and semiarid ecoregions of the Parque Chaqueño in Argentina.

One of the most important distinctive characteristics of rural communities is their relation to nature. The complex relationship between the adaptation and development of a certain society to a given environment is the foundation stone for the origin of rural cultures. Our results show that this relationship is affected by out-migration through two main processes:

Firstly, considering that culture is based on vertical and horizontal transmission of technical traits, knowledge and traditions, out-migration represents a disruptive process of cultural evolution. By pulling out the young cultural porters, the multiplication of traditions and perception of nature, are strongly affected. Our survey shows that both in the driest areas and semi-humid ones, traditions and institutions that regulate the sustainable use of natural resources are mainly kept in the elderly generations and less in the youngest ones.

The second process relays on the impact of out-migration on the life-strategies of the remaining families in the rural communities. Peasant families are forced to adapt their life strategies to a reduced family labour supply. The observed tendency is towards a diversification of income sources that is followed by a decreasing role of agriculture in the household budget. This generates a transformation of lifestyles based on the management of natural resources towards a new lifestyle in which the rural place is becoming only a place of living.

These findings attempts to postulate that out-migration, although not as a single and independent force, has a strong influence in transforming rural culture. The role of peasants in extending the appropriate management knowledge to next generation should be considered not only as a strategy for sustainable development support but also as keeping cultural diversity.

Keywords: Chaco region, rural culture, rural out-migration

Land Rehabilitation for Food and Energy Production — A Synergy Policy for the Tropics

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Approximately two billion hectares of now degraded land in the tropics have the potential to yield food. The (re)establishment of agroforestry systems is considered a suitable and sustainable solution for many areas. Other regions that are too arid for trees could supply drought resistant grass species, once soil fertility is restored. However, the effort of rehabilitation demands financial resources from abroad, for primary investments as well as to bridge the period until first harvest. These resources could be raised more easily if land rehabilitation became a profitable investment due to simultaneous production of food and renewable energy. Moreover, this policy would provide the opportunity for a self-sufficient development after the initial phase, because high quality energy carriers today have a higher export value than food.

The presented study describes food and energy producing ecosystems for land rehabilitation as well as feasible production-pathways of ethanol and hydrogen from biomass that can be supplied as excess fuel from rehabilitated land. Many woods and grasses provide efficient collection of solar energy and could be processed to either ethanol (EtOH) or hydrogen (H₂) in central conversion plants near their origin. Both energy carriers will play a key role in the future world economy: ethanol as a convenient biofuel for vehicles and hydrogen as renewable universal energy carrier and storage medium. Complementary to food production on rehabilitated land a net energy export of 50 Gigajoule EtOH / H₂ and more per year and hectare is possible. Respective proceeds of 1000,- € per year and hectare on the already existing market may well suffice to refinance land rehabilitation as well as the investment for energy conversion plants.

The development of renewable energies also will benefit from this policy, because biomass is an economic renewable energy source, and its co-production with food on now unused land entails considerably lower opportunity costs than most other concepts for large scale energy production. This obvious win-win-opportunity must not lie fallow.

Keywords: Agroforestry, biomass, ethanol, funding, hydrogen, land rehabilitation, renewable energy, self-sufficient development

Local Indicators of Quality of Soils in the Tropic (River Cabuyal Watershed, Cauca Colombia)

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The present paper is a contribution to validate the local knowledge as basic source for the local community to make decisions, because it is peasants who have a permanent contact with their natural resources.

The field study was put into effect in the river Cabuyal watershed Cauca Colombia, using a toposequence of 1,500 physical and chemical analyses of soils and the systematization of the local knowledge of the 50 peasants was managed with the help of direct interviews, workshops and a survey. It compared and verified the improvement of the quality of the soil from both the scientists and the local peasants' view.

The need for basic soil quality and health indicators is reflected in the question commonly asked by practitioners, researchers, and conservationists: "What measures should I take to evaluate the effects of management on soil function now and in the future?" Too often scientists confine their interests and efforts to the discipline with which they are most familiar. Our approach in defining soil quality and health indicators must be holistic, not reductionistic

Within the study's results, is observed the improvement of some chemical parameters of the soils (Carbon, Phosphorus, aluminium saturation, cation exchange capacity, CECE) appear. The agriculturists affirm that their soils have improved in the last twenty-five years due to the introduction of practices of soil conservation, but first of all to protect the soil with permanent cultures as is in this case the associated culture of coffee with trees (Agroforestry system).

Also the seven most important criteria of the agriculturist of the zone are exposed to evaluate the quality and health of the soil and are in their order of importance: Texture, color, plants as indicator, yield, organic matter, humidity, earthworm.

Keywords: Agroforestry, biology, soil, indicators of quality soil, local knowledge

Management Constraints of Cocoa Agroforest During Acquisition and Application of Pesticides in Humid Forest Zone of Cameroon

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Subsidies on pesticides (by purchasing, distributing, and applying) for many years allowed farmers in the humid forest zone of Southern Cameroon to maintain cocoa production at a reasonable level. In such conditions, cocoa allowed some 400,000 households to achieve basic needs such as food, health, scolarisation, wedding expenses, building houses, etc. . . The economic liberalisation in the early 1990s affected the cocoa and pesticides sectors by the withdrawing of the state in favour of the private sector and the farmers. This withdrawing led to some changes in farmer behaviour. This new behaviour needs to be studied to better help farmers in the management of their farms. This paper focuses on constraints faced by farmers when acquiring and applying pesticides in cocoa agroforest in humid forest zone of southern Cameroon. More than half of cocoa farmers use chemical pesticides. High cost and the lack of products are the main constraints faced respectively by 65 and 55 % of cocoa farmers using pesticides. These two constraints are the mains reasons given by 26 and 43 % of farmers who do not use pesticides. Among cocoa farmers, 21 % buy their pesticides in the villages while 20 % acquire them in town. Fungicides are the most used pesticides. But the frequency of their application is below standard. The low application of pesticides led to the decrease in cocoa production. To avoid this reduction, among the changes, farmers are now organising themselves in group to acquire and apply pesticides and developing, from local botanical knowledge and pest management strategies, mixture compositions of chemical pesticides and biopesticides (from plant extracts).

In the new context of liberalisation of the cocoa and pesticides sector, it is necessary to better diffuse good practices related to acquisition, storing, manipulation and application of pesticides in view of promoting integrated pest management in southern Cameroon.

Keywords: Cocoa agroforest, economics liberalisation, management of cocoa, pesticides, Southern Cameroon

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Evaluation of Land Conservation Measures in West Africa with Remote Sensing, Possibilities and Limitations

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The natural resources in West-Africa are under pressure. Fast growing population, numerous migrants and changing climatic conditions result in deforestation and soil erosion. As well, uncontrolled bushfires lead to a severe loss of nutrients. For protection of the environment and to secure food security, numerous development agencies undertook projects to protect forests, address soil erosion and incorporate appropriate fire management.

However, it is difficult to evaluate the success of these measures. Traditionally the measures are evaluated by field campaigns, but this method is expensive, time consuming and cannot cover the whole area of intervention. Remote sensing offers a better solution by observing wide areas at the same time.

In this contribution the possibilities and limitations of an evaluation of land conservation measures with remote sensing is presented. The research was carried throughout different test sites in West Africa.

To evaluate the success of forest protection and anti erosion measures, time series of LANDSAT images are utilised. Changes in the vegetation cover were detected with different change detection methods like principal component and change vector analyses, with the best fitting method for the specific conditions determined. Results of that investigations were tested by intensive ground truth campaigns.

To fulfil a sustainable fire management, it is forbidden in several parts of Benin to light bush fires after than a certain date to prevent nutrients being washed away with the onset of the rainy season. With three LANDSAT images representing different situations within the dry season, fire affected areas where detected by their spectral signature. It was then possible to detect areas with “late fires” and locate the villages which have broken the corresponding contracts. Also areas where fire is banned totally can be supervised.

The investigation shows that change detection with high resolution remote sensing is a suitable, efficient and comparatively cost-saving tool to evaluate the success of measures for land conservation. Limitations are caused in general by insufficient temporal, spatial or spectral resolution of the remote sensing scenes.

Keywords: Benin, evaluation, land conservation, remote sensing, West Africa

Regeneration Potential of Indigenous Tree Species from Forest Fragments in Exotic Tree Plantations in Ghana

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The conversion of tropical forests into forest tree plantations is widely practised throughout the tropics. Rather often the high expectations of economic and silvicultural benefits from tree plantations fail and stands become abandoned. Concepts for a revalorisation and silvicultural improvement of these stands are mostly missing.

The Institute for World Forestry of the Federal Research Centre for Forestry and Forest Products and the International Center for Graduate Studies, University of Hamburg in collaboration with DuPaul Wood Treatment Ltd., Ghana plans long-term field research in forest plantations of the Ashanti region in Ghana. As a perspective it is envisaged that the planted pure stands of Teak and Pine will partly be transformed into heterogeneous stands enriched with indigenous tree species. Several forest fragments with indigenous forest trees are still present in the area. The objective of this ongoing study is to assess the ecological status of these forest fragments and to evaluate their potential for natural regeneration and enrichment of the neighbouring plantations.

A tree inventory carried out as full sampling of the forest remnants revealed the basic stand information. After stratification into ecologically important groups, data allowed the calculation of characteristic parameters indicating details of the stand structure and the tree species diversity. Emphasis was put on reproduction mechanisms of the indigenous trees and the investigation of their seed dispersal. Especially birds appeared to be a key factor for the seed distribution over short to medium distances. Their presence and effectiveness was assessed. Thereafter the regeneration potential could be evaluated for the forest fragments and neighbouring exotic species stands. Based on these results silvicultural management recommendations were elaborated.

Keywords: Ghana, regeneration, seed dispersal, tree plantations

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NTFP in Tropical Forestry — Disappointed Expectations, Undervalued Resources

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Expanded and improved commercialisation of non-timber forest products (NTFP) will increase cash incomes of rural households in tropical countries, thereby motivating local actors to conserve natural forests. This expectation has recurrently been raised by environmentalists and development professionals over the past 15 years. Notwithstanding the scarcity and erratic nature of data on NTFP extraction, on NTFP business in individual countries and on trade at the global level, there is evidence that NTFP indeed represent an impressive economic asset. However, more and more researchers question the viability of NTFP economies and their contribution to the conservation of tropical forests. Some of the sceptical arguments in this context are:

- Once NTFP become high value goods on national or international markets, there is the risk of resource base overexploitation.
- Successful NTFP face competition from plantation products and other substitutes.
- The bargaining power of rural households tends to be weak, so that they are deprived of lucrative NTFP resources by external actors or only receive a meek share of added value.
- Producer-to-consumer-chains of NTFP often are weak, so that NTFP commercialisation fails to be successful. Deficits are identified especially at the early steps of the chains, where rural households are directly involved and where improvements are difficult to be realized.

The paper reflects these arguments against the background of recent empirical research. It concedes that many of the expectations connected with the mobilization of NTFP, as formulated at the end of the 1980s, definitely came out to be unrealistic. Undoubtedly, however, the extraction of NTFP from natural tropical forests, their processing and sale still offers prospects for improving the income of numerous rural households, at least during certain phases of regional development. There is the unchanged challenge, though, to improve NTFP extractive economies in a way that rural households involved participate in the benefits of change. Systematic analysis of NTFP case studies helps to identify promising approaches on this way.

Keywords: Extractive economies, forest conservation, NTFP, poverty alleviation

Institutional and Technological Innovations in NTFP–Cluster Promotion — The Case of the Bamboo (*Guadua angustifolia*) Sector in Colombia

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As part of an EU/INCO funded cross-disciplinary research project on “Sustainable Management and Markets of Bamboo in Costa Rica and Colombia”, a marketing study served as a starting point for a stakeholder and institutions analysis of the Colombian bamboo sector. In the Colombia Eje cafetero (coffee belt) located between 1,000 and 1,800 masl in the inner valleys of the Colombian Andes, the native bamboo species *Guadua angustifolia* is the dominant vegetation form. For local users it is the most common source of wood for day to day uses. The existing 30,000 ha of *Guadua* (representing about 60 % of Colombia’s total bamboo resources) are mainly distributed in small stands of a few ha on private property. Currently, the vast majority of the bamboo harvested in the region (an average of around 30,000 m³ per year) is used in temporary, auxiliary purposes in the construction sector with no significant value-added. The world-wide coffee crisis of the 1990s and an earthquake in 1999 have led to a new appreciation towards bamboo resources involving a large number of actors in the region. Against this background, meso-level actors, such as regional environmental authorities, research entities and NGOs, but also independent bamboo experts try to launch a bamboo related innovation and development process, building on comprehensive extension activities and the introduction of new processing technologies. The intention, especially of the governmental actors, underlying this process touches at socio-economic and ecological as well as socio-political aspects, including aspects of public order and illicit drug production. The study analyses and evaluates the behaviour and strategies of the wide arena of actors involved in the process, such as public and private sector actors and micro-level producers and processors. The research clearly reveals that the behaviour of actors can be adequately explained with the principles of transaction cost analysis and bounded rationality affecting their participation in the process. Furthermore, the capacity and willingness to co-operate is crucial to the whole process, but is not found amongst a huge number of the affected actors in the sector. Therefore, the rules of interaction and influencing between actors were especially focused in this study. This insight might serve as an important reminder to all those planning development processes and trying to induce innovation processes in the non-timber forest products sector, where usually a much larger number of actors is involved than in other productive sectors. Furthermore, it may help to understand how the upgrading process from mere survival clusters to industrial clusters can be initiated and guided.

Keywords: Cluster development, induced innovation processes, non-timber forest products

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Differentiation in Benefits from Forest Devolution in Daklak, Vietnam

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Proponents of devolution typically presume that local people benefit from devolution. The rationale is that devolution provides local people with access to and control over forest resources that make important contributions to local livelihoods. This paper subjects this assumption to empirical analysis through a study of two villages in Daklak province, central high land of Vietnam, where (part of the) local forest has been devolved to local ethnic people for long term (50 years) management. The study's main objective is to examine the (material) benefits generated by devolution of forest for local households as a whole as well as the differentiation of benefits among local households, including both recipient and non recipient groups living in the same village.

The study gives attention to both the distribution of benefits and the mechanisms that differentiate benefits between households. It employs qualitative as well as econometric tools in the course of data analysis. In general, results from the study demonstrate that benefits from forest devolution may significantly differ between villages. Devolution has generated insignificant benefits from timber but significant benefit from cultivable land in one village. By contrast, in the other village significant benefits from timber but insignificant benefit from cultivable land were observed. In addition, household displayed stark differences in their capacities to benefit from forest devolution. Power relations, wealth differences, and forest link (i.e. traditions and previous production activities by local villagers with regard to the devolved forest) have been the primary factors influencing the acquisition of benefits by local households from devolved forests.

Keywords: Differentiation, forest devolution, power relation, Vietnam

High Altitude NTFP Sub-Sector in Nepal — Opportunities and Constraints for Livelihoods Improvements

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Nepal with its peculiar convergence of topographic, climatic, and edaphic factors has high floral diversity as well as unique ecosystem diversity. High mountains of Nepal are home to a diverse range of high-value non-timber forest products (NTFPs). NTFPs of Nepal Himalaya are of critical importance to hundreds of thousands of rural people as sources of nutrition, health care, raw materials and cash income. It is further critical to the poor as they are the ones mostly involved in the collection of NTFPs.

NTFP sub-sector in Karnali has unique features. Transportation of NTFPs is solely based on airlifting by plane or helicopter to Nepalganj and then to India. Almost all the traded NTFPs are exported to India in raw form, while some value additions are being tried within the region in an attempt to obtain better prices. The lack of NTFP management and the increasing national and international market demand encouraging intensive harvesting are leading to a decrease in the diversity, quality and availability of the NTFPs. In turn, it affects seriously the plant biodiversity and local collectors, who depend heavily on NTFPs to meet their basic needs.

This paper identifies and analyses opportunities and challenges in the NTFP sub-sector in terms of political, economic, social and resource dimensions and suggests priorities for livelihoods improvement opportunities from the sustainable management and optimum use of NTFPs. It is based on authors' discussions with stakeholders at national and district levels, local government bodies, community forest user groups, field observations in Karnali zone of Mid-Western Nepal. This paper explains the opportunities and constraints in policy, regulations and practices; the NTFP resource base distribution and occurrence; utilisation pattern of NTFPs; collection and management practices of NTFP resources; processing, trade and market channels; and equity aspects NTFP sub-sector in Nepal and it concludes with the possible areas of leveraged interventions in the sub-sector.

Keywords: Community forestry, livelihoods, Nepal, non-timber forest products, stakeholder analysis

Afforestation of Private Land in the Ashanti Region of Ghana — Experiences with *Tectona grandis*

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The Ashanti region in Ghana is located in the transition zone between savannahs and moist deciduous tropical forest and shows a distinct dry season. Although Teak (*Tectona grandis*) is not a natural species in Africa, its growth performance is exceptionally good. A lot of experiences with plantation establishment exist and a “best practice guide” has been drafted. However, plantation establishment of private investors is different to those working on government land with donor money. The involvement of local chiefs is a key-issue that many plantation managers have underestimated. Thus, fire is a major threat to young plantations. DuPaul Wood Treatment Plant has meanwhile seven years of experience in planting teak. A small plantation near Papasi is assessed in terms of vegetation classification, assessment of timber resources (in quantitative and qualitative terms), the description of soil and site conditions, and the chemical analysis of soil conditions.

The Papasi plantation is approximately 202 ha in size, whereof 67.5 ha are covered with one to seven years old Teak stands. Most of the rest is presently under agricultural use (72.5 ha) by the surrounding villages. An area of 17.8 ha is grassland and around 5 ha comprise of natural forest fragments. A post-inventory stratification was carried out which subdivided the stands into “older stands” (planted 1996–1999) and “younger stands” (planted 2000–2002). In all strata, fires in the dry seasons and poor weed management resulted in a high mortality rate (42.5 %) and poor tree qualities. An additional stratification was carried out to subdivide into “poor” and “better stands”. The growing stock of the “better stands” ranged from 87 m³/ha for seven years old stands to 30.96 m³/ha for 5 years old stands. The mean annual increment ranged from 14.5 m³/ha-yr to 6.19 m³/ha-yr. The timber quality assessment identified only 22 % of the stems as pole or saw timber quality, 78 % had to be categorised as firewood or wood for rural constructions purposes.

Based on these results, a silvicultural management concept is elaborated to increase the portion of stands with better growth and quality.

Keywords: Ghana, growth, silviculture, teak

A Few Important High Altitude — High Valued Non-Timber Forest Products from Nepal

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Nepal is rich in green vegetation, herbs, and mineral wealth. The flora of Nepal consists of some 7,000 species of vascular plants of which 252 are endemic. There are more than 75 vegetation types spread across an area of 147,181 square kilometers. More than 700 species of medicinal plants grow wild in the country, majority of which are used in folk herbal remedies. More recently traded in relatively large quantities, NTFPs have had traditional food, medical and ritual uses in Nepalese communities. Every year, over fifteen thousand tons of NTFPs representing some 100 species are harvested from the wild for commercial and industrial purposes.

This poster provides the brief description on distribution, ecology, habitat, uses, used parts, market information and conservation status of six high valued-high altitude NTFPs from the Nepal Himalaya. Which includes Rockfoil (*Bergenia ciliata*), a rhizomatus medicinal plants used for fever, kidney stone and fracture treatment; Yarsagumba (*Cordyceps sinensis*), a most expensive fungus fetching upto 1000 € per kg dried product in the local market; Spikenard (*Nardostachys grandiflora*), an aromatic plant which has been processed at the local level enterprises; Chiraito (*Swertia chirayita*), an expensive medicinal herbs sold in local market and used as medicine for headache; Salep or Orchid (*Dactylorhiza hatagirea*), which is banned for collection, distribution and trade by the government of Nepal; Morel (*Morchella conica*), one expensive and well exported mushrooms; Indian rhubarb (*Rheum australe*), one of the species used for food and also being traded; Indian Valerian (*Valeriana jatamansii*), an aromatic species which is processed by the locally based enterprises.

Keywords: Nepal, high value-high altitude NTFPs

***Grewia tenax* — A Potential New Small Fruit for the Sudan**

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Of the estimated one million plant species worldwide, only a minute fraction serves as food, medicinal and industrial sources. Most of these crops were domesticated thousands of years ago and have been the subject of much global interest in research and development. The remainder, which comprises a vast array of plant species, remains largely neglected, although they often play a major role in subsistence consumption and/or income for the rural populations. This may very well be the case with the small-leaved white crossberry, *Grewia tenax* (FORSK.) FIORI. It is a fruit-producing deciduous, tropical shrub or tree, widespread in semi-arid and sub-humid tropical climates. In spite of its potential, which is well recognized, commercial plantations in the Sudan are practically nonexistent. Wild plants are continuously being used to meet the growing commercial demand for the fruit. Recently, alternative and potentially high-value cash crops are being sought for their potential to help supplement the incomes of small farmers who are currently dependent upon growing and selling millets, sorghum, sesame and groundnut. *G. tenax*, has often been cited as prime candidate for domestication as a useful horticultural plant. One major factor hampering this development is the limited and scattered knowledge available on this species. Therefore the purpose of this poster is to highlight the importance of this species by assembling existing information on its biology and horticultural characteristics. It is hoped that this information will contribute to: (1) providing information on different aspects of the species in a readily available form, (2) detecting existing gaps in available knowledge, and (3) identifying constraints to its domestication and commercialization and indicating possible solutions.

Keywords: Arid and semi-arid, commercialization, domestication, *Grewia tenax*, underutilized fruit

Drought Tolerance of *Grewia tenax* — A Potential New Small Fruit for the Sudan

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Grewia tenax, a fruit-producing shrub, is considered a prime candidate for domestication and commercialisation as a new crop for the semi-arid regions of the Sudan. It occurs on a large area, regenerates well, and is traditionally protected during clearing and favored by farmers. Ecologically, it can withstand environmental stress more easily than annual crops and thus make an important contribution to sustainable production without needing expensive inputs of water or fertiliser. The fruit is an important economic commodity, both locally, where it is used as food and folk medicine, and internationally, where it has great export potential for use in food and pharmaceutical industries. However, most of fruit production results from gathering activities. Shrub populations are wild and annual fruit yields are erratic and variable due to increased pressure from agriculture, drought, and predation.

Drought is a major abiotic stress that severely limits crop production in arid and semi-arid areas. The characterisation of water relations and growth is a prerequisite for subsequent selection and genetic manipulation of drought tolerance. In this project, we examined different provenances of *G. tenax* with the objective of identifying the specific mechanisms at the whole-plant and cellular levels responsible for drought tolerance. The material under study covers a wide range of climatic and edaphic conditions. Results show a range of responses to different drought intensities suggesting a high degree of plasticity in response to water deficits. Drought-tolerant provenance is characterised by low stomatal conductance, high osmotic adjustment, extensive root growth and small reduction in leaf growth under water stress conditions.

Keywords: Drought tolerance, *Grewia tenax*, growth, leaf gas exchange, underutilized fruit, water relations

Quality Aspects of Honey Locally Processed and Marketed in Uganda — Implications for International Markets

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Honey is of growing economic importance worldwide. Maintenance of natural honey quality developing countries is essential for premium price markets and in protecting consumers from potential health hazards. This study assessed the quality of locally processed and marketed honey (branded and unbranded) across major retail groups (supermarkets, hawkers and stall markets) in Uganda. The honey moisture content (MC), free acidity (FA), diastase number (DN), hydroxymethylfurfural (HMF), water insoluble solids (WIS) and total acidity (TA) were analysed.

Significant ($p < 0.05$) differences in HMF concentrations and DN among branded honey types were observed. However, there were no differences ($p > 0.05$) in MC, FA, TA and WIS values of all brands studied. While 80 % of the brands had MC and HMF values meeting the Uganda and Codex Alimentarius quality standards, only 60 % had the required DN qualities. With regard to the European market standard, only 40 and 20 % of brands would qualify in terms of HMF and DN restrictions, respectively.

With respect to Uganda's and international standards, retailed honey qualified only in MC and HMF. Free acidity, DN, and WIS were the main bottlenecks to honey quality in Kampala's retail groups. For the European market, honey from Kampala's retail groups only qualified in moisture content. From the international (Codex Alimentarius and EU) standards standpoint, the brands only qualified in MC, HMF, DN and WIS. It was concluded that supermarket honey is superior to Stall- and Hawker-marketed honey. For Uganda's honey to make it to the international markets, it is recommended to enforce quality standards at all levels of honey production, processing and marketing.

Keywords: Honey processing, honey quality, Uganda market

Adaptive Cluster Sampling in NTFP Research

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In natural tropical rain forests the relative abundance of certain species is relatively low (< 5 individuals per hectare). Due to individual dispersal patterns or site changes on the micro level some of these species tend to occur in groups. Ordinary forest inventory designs are ineffective in analysing the abundance and spatial distribution of rare, clustered species.

A cooperation project of the University of Freiburg with the Federal Research Centre for Forestry and Forest Products was carried out with the objective to compare the effectiveness of an adaptive cluster sampling with primary and secondary units and an ordinary strip sampling. The data recording was carried out in a secondary tropical forest in central Cameroon and was conducted with chosen NTFP species.

Keywords: Cameroon, geographic information system, management plan, non-timber forest products

Ecology and Socio-Economic Importance of Shortened Fallows in Southern Cameroon — Productivity of Selected High-Value Species

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The major indigenous key productive fruit trees identified by farmers throughout the humid forest zone of southern Cameroon include *Coula edulis*, *Dacryodes edulis*, *Irvingia gabonensis* and *Ricinodendron heudelotii*. A study was undertaken to characterise the phenology of non-timber forest species in a fallow farming system of southern Cameroon, and to examine the phenological patterns in relation to land use. Leaf flushing, flowering and fruiting phenology of each study species were investigated and patterns of fruit production monitored. Results from this study will lead to recommendations for the design of appropriate conservation and management decisions and plans that will improve the productivity and guarantee the sustainability of shortened fallows in the area. Three land use types were defined: short fallows (of less than 7 years old), medium-term fallows (of 7–10 years old) and long-term fallows (of more than 10 years old). *Coula edulis*, *Dacryodes edulis*, *Irvingia gabonensis* and *Ricinodendron heudelotii* were recorded at very low density values in fallow lands of the study area (< 10 individuals of more than 10 cm dbh), suggesting the need to develop preferential management of regeneration for these species. Apart from leaf flushing, flowering and fruiting phenology of these species were seasonal, with irregular flowering/fruiting observed for some *D. edulis* and *I. gabonensis* individuals over the two years of monitoring. Fruiting was concentrated between July and October (and up to January for *R. heudelotii*), coinciding with the rainy season. An individual of *C. edulis*, *D. edulis*, *I. gabonensis* and *R. heudelotii* produced, on average, nearly 236 fruits (9.6 kg fresh weight in 2001, 335 fruits and 11 kg in 2002), 235 fruits (12.5 kg in 2001 and 801 fruits, 51 kg in 2002), 547 fruits (72 kg in 2001 and more than 2002 fruits, 133 kg in 2002), 2018 fruits (72 kg in 2001), respectively. Regression analyses showed that tree size parameters are correlated with fruit production for some species, but generally, do not explain an important part of the production data of the study species ($r^2 < 60\%$).

Keywords: Fallow, non-timber forest products, phenology

Alternative Income Generation Using Non-Timber Forest Products (NTFPs) in the Huascayacu Native Community, Alto Mayo, San Martin, Peru

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The Aguaruna community of Huascayacu is located in the district of Moyobamba, north-west of Peru. In spite of the fact that physical and legal property delimitation has already been assigned by the state, the community is facing the threat of violation of their property by settlers due to pressure of migration. Moreover, there are indications that the native people are adapting customs from the settlers e.g. slash and burn to facilitate agriculture or the rearing of livestock. This leads to short-term benefits, but is devastating for efforts towards forest conservation and brings about changes in their traditional way of life. Nowadays, the community of Huascayacu uses wood and coffee for income generation, only. However, dealing in timber generates insignificant economic income and the revenues from coffee cultivation on a volatile market are an unreliable source of income. The principal aims of this study were (1) to gather information regarding the use of non-timber forest products (NTFPs) by the local people, (2) to determine future possibilities for sustainable use and for commercialisation of NTFPs, and (3) to make suggestions for alternative income generation employing “traditional species”. To achieve these goals interviews were carried out at the Huascayacu Community (covering 70% of the households) and in local markets, with special emphasis on big cities where the products may be marketable. Information about the abundance and distribution of the species was taken from the forest inventory and from the biodiversity analysis elaborated previously. Botanical samples were identified at the Herbarium of the University of Agraria La Molina, Lima, Peru.

Combining socio-economic information about the uses and marketing of NTFPs with the biological data taken from the sources mentioned above, appropriate NTFPs such as fruits, seeds, vines and medical plants were identified. Furthermore, the local consumption of these plant products was measured, to determine the surplus which could be traded. Finally, some recommendations for the different silvicultural treatments that should be applied to the target species are explained. We expect to make strong suggestions for alternative income generation using NTFPs in order to benefit the Huascayacu Native Community.

Keywords: Alternative income generation, forest management, NTFPs, Peru

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Non-Timber Forest Product and its Role in the Local Economy — The Case of Bandhavgarh National Park, India

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Non-timber forest products (NTFPs) play a major role in sustaining livelihoods of people in rural areas. In a country like India, with has more than half of it's population living in rural areas and a large tribal population, reliance on forest products for meeting their daily requirements and income generation is crucial. The term NTFP encompasses a wide range of forest produce including fruits, nuts, berries, honey, seeds, grasses, gums & resins, medicinal plants and fuelwood.

This poster makes an attempt to show the degree of reliance of people on NTFP collection and it's role for the survival of the people. This is done through a case study of people living in Bandhavgarh National Park, India, based on a field study conducted in 2001. The study revealed that the majority of the sampled households (97 %) collected NTFP. Besides being an important food source for people and their livestock, NTFP collection also contributed substantially to household income (26 %). Of the six sources of income for the people living inside the park including agricultural production, livestock rearing, working for the forest department, working outside the park, other alternative sources of income, NTFP collection comprised the most important source of income along with work for the forest department. As it is a national park, NTFP collection was banned in the park in 1990 but the government was forced to restart the collection of NTFP in the area in view of the importance of NTFP for people living in and near the park.

Keywords: Bandhavgarh national park, India, local people, non-timber forest products

The Role of Root and Tuber Crops in Enhancing Development in the Coastal Region of Cameroon

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A wise planning and management of natural resources so as to secure their sustainability to ensure continuity of supply while maintaining and enhancing their quality, value and diversity attain rural development. Environmental degradation is highly contributed by the activities towards food production mostly by the local populace who are much engaged in agriculture for their livelihood. Their activities expose the soil surface during tillage which increase desertification, destroy virgin forests, and land. Such acts results in shifting cultivation which alters ecological balance of species, frequently contaminating water bodies with the farm chemicals often applied to boost production thus greatly contributing to environmental degradation which had been escalating in the past two decades and poses threat to increase in future. A large population of Cameroonians practice subsistence farming and yet a high level of food insecurity still prevails with low economic returns. Most farmers cultivate cereals, which forms 50 % of the first ten staple food in the area.

Root and tuber crops can contribute tremendously in redressing the odds cited with the concentration on cereal crops for their staple food. The potentials of the crops to more than double its production will go a long way in contributing to feed the 40 million Africans who are hunger striven. The potentials of these crops include: ability to grow compared to cereals, ability to grow in humid and sub-humid tropics with marginal soils thus serving as a better risk in environments where drought is a threat, minimal release of methane to the atmosphere compared to cereals, provide broader leaves that can be prepared as soup and which also serve as soil cover, minimal requirements of farm chemicals, relatively pests and diseases free, relatively higher productivity and highly efficient of edible carbohydrates. Harvesting, transportation and storage technology are constraints that limit the cultivation of the crops, which if overcome, could replace the other fraction occupied by cereals, which will boost production and environmental sustainability hence improving the lives of the local populace.

Keywords: Agriculture, degradation, development, environment, root and tuber, sustainability

Tree Growth Dynamics of Two Natural Secondary Gallery Forest Stands in West Yen Tu Reserve, Northeast Vietnam

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The gallery forests are described as the generally narrow patches of woodland running along edges of watercourses and banks of lakes. The forest type forms an important habitat for terrestrial fauna and serves as a food source for aquatic fauna. Furthermore it has a function as buffer zone in controlling water supply and erosion. Despite the important ecological role in water protection as a shelter for associated fauna, in biodiversity conservation, in the contention of erosive processes for the region, gallery forests in Northeastern Vietnam are continuously degraded by anthropogenic activities. Thus, promoting the *in-situ* bio-diversity conservation needs to be intensified and associated with multi disciplinary knowledge. Whereby, not only vegetation composition, structure and dynamics of the gallery forests, but also their reaction toward the site condition were elaborated. Because of the lack of basic knowledge about the study areas tree ring analysis is meaningful for describing and interpreting the stand and tree dynamics and development.

In two natural secondary gallery forest stands in Northeastern Vietnam, the inventory was conducted on transects (10 × 50 m) along two rivers, which are located in the watershed area of Luc Nam river belong to the West Yen Tu reserve. In 40 transects with total area of two hectares all the trees with diameter at the breast height (DBH) over five cm are included. For tree rings analysis five dominant tree species in two study sites (*Erythrophloeum fordii* OLIVE., *Castanopsis indica* A.DC, *Pygeum arboreum* ENDL., *Lithocarpus ducampii* A. CAMUS and *Mischocarpus oppositifolius* (LOUR) MERR.), which show distinct annual rings, were selected. 70 trees were cored at the height of 1.3 m with increment corers and analysed using standard dendrochronology methods in Göttingen. The objectives of this research is to investigate the relation between annual tree rings and precipitation and growth dynamics of dominant tree species.

Keywords: Forest dynamics, gallery forest, silviculture, tree rings analysis, Vietnam

Sustainable Cork Production in Changing Mediterranean Agroforestry Systems

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Mediterranean forest ecosystems play an important role in the conservation of soil and water resources and in rural economies. Large areas have been degraded and must be restored, but others show models for sustainable management in woodland systems able to prevent a further loss of biodiversity and resources. The importance of persisting traditional land-use systems compatible with the conservation of Mediterranean forests is increasingly recognised by rural development and environmental policies. Western Mediterranean oak forests are the result of a long process of transformation by human activities and demonstrate that a sustainable balance between trees, crops and cattle is possible. Different types of evergreen cork and holm oak woodlands are modified and maintained by constant human intervention in local agroforestry and sylvopastoral systems showing a great variety of products, as well as a high level of biodiversity. The contribution presented here deals with the cork oak (*Quercus suber*) as an outstanding element of a complex, multifunctional and changing land-use system. In those areas of Portugal, Spain and Maghreb countries, where cork production is concentrated, cork harvesting is of fundamental socio-economic importance, generally together with different complementary activities. Controlled cork stripping at regular intervals is possible without damage to the tree. The cork bark constitutes one of the most important non-timber forest products world-wide. Growing environmental awareness has raised economic interest in cork as a natural, renewable, biodegradable and recyclable product with a large number of applications. Nevertheless, the cork sector and the agro-sylvo-pastoral system as a whole suffer various problems, mainly related to recent changes of external conditions. There is a need for innovative adaptation in all segments of the cork production chain. A regeneration of cork oak woodlands and a higher qualification of labour are as important as technological and organisational innovations in industrial transformation and marketing. Great efforts are indispensable to stop the decline of traditional land-use systems, which also incorporate new production and service activities in a Mediterranean rural landscape of extraordinary attractiveness and socio-economic and ecological value.

Keywords: Mediterranean agroforestry systems, subtropical oak woodlands, cork production, sustainability

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Sustainable Forest Management in Amazonia Based on Tree Ring Data

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Sustainable management of forest is in international discussion as one attempt to protect tropical forests ecosystems. Many criteria and indicators are developed for the certification of such systems. The key-indicator however is the wood increment of trees and of forest stands, its knowledge is poor. Estimates are vague and vary considerably in dependence of species, site and measurement method.

Growth rates and ages of tropical trees often give occasion to controversy discussions due to the assumed absence of annual tree rings. In fact the existence of annual rings in tropical trees under seasonal precipitation conditions is proven since the beginning of our century. The trigger for the annual growth period is either a periodical inundation as it occurs in the annually flooded areas of great streams or periodical dry periods of two or three months as they occur in most non flooded areas in the tropics, even close to the equator. The seasonal climate type with one distinct dry season is widely distributed in the humid tropics.

In a reserve at the middle Amazon close to the city of Téfé the Institute Mamirauá develops in co-operation with the local inhabitants management plans for sustainable use of the natural resources and concepts for the protection of rare animal and plant species. One important part is the plan for sustainable forest management. This includes the investigation of growth behavior of timber species by means of tree ring analysis. The modelled growth patterns show a high variation in radial, volume and biomass increment. The model indicates an optimal period for logging between the peaks of current and mean volume increment. The cutting cycle in the reserve is presently limited to 25 years for all species. Our results show that the cycles must be adapted specifically to avoid overexploitation of the slow growing and to allow economical use of faster growing species. The investigation can be used as a model for the estimation of sustainable wood growth in other tropical forest ecosystems.

Keywords: Sustainable forest management, tree rings

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The Scale Issues in Assessing Matter Fluxes and Balance In/out Agro-Ecosystems

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Define the boundaries of the agro-ecosystem and that of its components, and precise the time step considered when assessing matter fluxes within, or in-and-out, agro-ecosystems seem common sense. Unfortunately, it is not systematically done, often just because it is felt trivial and remains implicit, or because of complex interactions between intervening processes organised at various spatial and temporal scales.

Recent attempts to assess C, N, P, and sometimes K, fluxes and to calculate their balances in savannah agro-ecosystems of South Saharan Africa have implicated both, the multi-scale pattern of heterogeneity of the natural resource, and the multi-layered pattern of land use and tenure systems. High local diversity is related to geomorphologies inherited from alternant arid and humid periods during the quaternary and their impact on rain and nutrient redistribution in the landscape. Contrasts are enhanced by the strength of single-season tropical rainfalls, and by the selective land-use. Farm-household and village communities constitute the main scales at which natural resource management and agriculture production are organised. However, the geographical attributes of these scales are not straightforward. Indeed, property rights in rural areas largely bear on the traditional usufruct and access rights attached to the different products and not to the land. The rights to crop are generally separated from the rights to manage and use grazing resources, including those of the stubbles, and also separated from gathering rights that may differ with the product gathered. Grazing rights are communal, spatially organized from key resources: water points, livestock path and resting spots. They are not exclusive and are organised through calendar and priority access negotiated between stakeholders.

The challenging overlay of complex and dynamic land use pattern over heterogeneous landscapes is now eased by the development of GIS software. Because of different time scales and many decision makers involved in the management of natural resource GIS are associated with mathematical modelling to assess matter fluxes and balances. The performances and limits of GIS and mathematical models to solve the scale issues in these assessments are discussed and recommendations made for further developments.

Keywords: Matter fluxes, agro-ecosystem, land use pattern, GIS

Environmental Impact and Socio-economic Incentives of Contrasting Land Management Systems in Southern Namibia

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Marked fence-line contrasts are ocular outcomes of the effects of different natural resource managements in the dryland rangeland of southern Namibia. Within the framework of the interdisciplinary BIOTA Southern Africa project, comparative investigations were carried out on a pair of permanently marked Biodiversity Observatories at the Gellap Ost Research Station and the neighbouring Nuwefontein Communal Land. Results show that on the historically more intensively used communal farm there is an overall decline in perennial vegetation, especially within low-growing life-forms. Short-term annual growth in the rainy season is followed by extensively barren surfaces during the dry season. In direct vicinity, the site on the governmental Research Station looks intact. The access of livestock to the camp is timely restricted and indicator plants are regularly monitored in order to prevent overgrazing. Overall stocking rates are low also because of missing economic incentives due to fixed budgeting. These circumstances ensure a dense grass-cover throughout the year. The state of the natural resources on both sites is strongly influenced by present and past motives, actions and constraints of land users as well as other stakeholders, population pressure and the change in incentives set by institutions, such as the (re-)distribution of property rights. In particular, the shift of rights and governance away from local users to government authorities as an outcome of apartheid-related policies and incomplete reforms has led to a situation where practised communal resource management is unable to rehabilitate degraded rangeland and to maintain biodiversity. Apart from the human impact on changing biodiversity the effects of degradation on farmers livelihoods have been investigated. The general decline in self-generating natural capital and the increase in the seasonal fluctuation in available biomass increases the risk for farming making additional sources of income indispensable. In the observed communities, multifunctionality of livestock keeping lost importance resulting in decreased pressure on resources as well as reduced incentives to maintain them. Based on a participatory approach, and firmly embedded in local realities, interdisciplinary investigations into the socio-economic processes and ecological effects of various land use systems will form the basis for proposing biodiversity maintenance strategies.

Keywords: Biodiversity, biomass, fence-line contrast, governance, land use, Namibia,

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property rights

The Taï Region Project on Hydrology — Input and Pathways of Nutrients in a Watershed in Western Côte d'Ivoire — A Comparison between Forest and Cocoa Plantations

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The Taï region project on hydrology was initiated in April 2001. Within an active cooperation between the Landscape Ecology unit of the University of Göttingen and CURAT of the University of Abidjan two main aims are pursued: 1. The characterization of nutrient pathways of the agricultural dominated part of the watershed in Western Côte d'Ivoire and 2. the development of a new method to evaluate water quality in the tropics. The investigation site and instrumentation covers three investigation plots (forest and two cocoa plantations) at the Eastern border of Taï National Park.

On each plot inputs and pathways of nutrient ions, organic carbon and nitrogen species are recorded, encompassing precipitation and throughfall concentrations, as well as measurements of the soil water (in 25, 65 and 105 cm depth), the ground water and the surface water export.

In addition to the soil investigations, surrounding land use is classified using satellite imagery. Besides, local people were interviewed giving a survey over crops and agricultural practices. Preliminary results concerning nutrient inputs and characteristic pathways within the ecosystem are presented, as for example following the pathway of magnesium (Mg) at the forest plot giving mean values. A significant increase of Mg occurred from precipitation (0.07 ppm) to throughfall (0.59 ppm) (leaching) up to the upper soil horizons (0.81 to 1.14 ppm). The passage of the rooting zone (0.42 ppm) led to a significant decrease which is likely due to root uptake. Resulting from mineral weathering processes and superficial input a further increasing step is detected between groundwater (0.06 ppm) and river water (1.91 ppm). These effects may also be responsible for the very high concentrations of sodium (up to a mean value of 80.5 ppm in 65 cm depth) found in soil solutions of all depths for both forest and cocoa plots. Potassium significantly shows an increase due to leaf leaching (e.g. cocoa 1) from precipitation (0.35 ppm) to throughfall (3.85 ppm). The high concentrations of potassium within river water (1.27 ppm) is considered to result mainly from direct input of organic material by dense river bank vegetation.

Keywords: Cocoa, Côte d'Ivoire, nutrient pathways, tropical rain forest, water and nutrient cycle

Spatial Patterns of N₂-Fixing Legumes in Secondary Forests

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Slash-and-burn agriculture relies on the regeneration dynamics of secondary fallow regrowth to recuperate the productive potential lost in the burn and short cultivation-phase. Losses are particularly heavy for nitrogen, both to the atmosphere and via nitrate leaching. Biological nitrogen fixation (BNF) by legume-rhizobia symbiosis is the main pathway for secondary forests to recuperate these losses and satisfy N-needs during the biomass buildup. However, our knowledge on BNF remains insecure, since the ¹⁵N natural abundance method fails to quantitatively estimate BNF in tropical forests. Research on BNF needs to meet with the heterogeneity and complexity of these forests, the present study pursues the spatial pattern of legume-BNF along secondary forest succession.

Research was conducted in a 15-site (7.9 ha) chronosequence of 2- to 25-yr.-old fallow regrowth in Central Amazonia. We mapped all legume plants >50 cm height, allometrically estimated their biomass, and identified >98 % of them to the species-level. Foliar $\delta^{15}\text{N}$ -signals of potentially N₂-fixing legumes and of selected non-legume species were obtained by spatially systematic sampling.

Visual assessment of maps reveals an irregular distribution of potentially N₂-fixing legumes throughout succession and suggests clustering at short to mid distances and random distribution beyond. Point pattern analysis confirms these observations, indicating maximum clustering at 5–10 m distance on all sites and for most species. Legume vegetation is organized at the species-level and species-grouping by genus or growth form obscures such patterns. Spatial organization apparently also changes systematically along succession, as demonstrated for the common liana species *Machaerium hoehneanum* DUCKE (Papilionoideae).

The spatially aggregated distribution of potentially N₂-fixing legumes gives room to the hypothesis that BNF is likewise irregularly distributed. We investigate the spatial pattern of BNF by interpolating the foliar $\delta^{15}\text{N}$ -signals of potentially N₂-fixing legumes and of non-legume reference plants. The resulting BNF-estimates are irrelevant in absolute terms, but nevertheless indicate that BNF is concentrated in small to mid-sized 'hotspots'. Such BNF hotspots are expected to affect vegetation and topsoil in their surroundings and to form microsites with elevated N-turnover.

Keywords: Biological nitrogen fixation, capoeira, legume, nodulation

Changing Tropical Diversity of Marine Systems in Panama

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Marine and coastal biodiversity is one of the programmes of the Convention on Biological Diversity (CBD). Corals are endangered world-wide, estimations end of 2000 were that approximately 27 % of coral-reefs are destroyed already. This poster demonstrates the situation of the coral reefs at the archipelago of Bocas del Toro in the tropical climate of the Caribbean coast of northwest Panama. In April 2000 three different research spots of healthy and dying patch reefs were examined closely in their richness of species and grade of destruction by sedimentation and the growth of seaweed. The reefs showed the signs of severe degradation.

The factors endangering the coral reefs are extensive banana plantations wide-spread in the region being the cause for loads of sediments and pesticides which are washed down the rivers into the sea and damage the corals in their biological processes. After harvesting, the banana industry is shipping the fruits for the export overseas conserving them with chemicals. Contamination by oil originating from the ships and also by diesel from the numerous small boats being the only mean of transport between the islands and the mainland endanger the sea water. With the beginning of tourism since about 1997 an uncontrolled infrastructure development began. Construction activities and deforestation on the islands lead to additional sedimentation deteriorating the light conditions. Poison from inadequately detoxified waste and nutrient entries with the waste water disturb the ecological balance of the sea. The consequences of a heavy earthquake in 1991 accelerate the already worsening situation of the patch reefs due to geomorphological changes on the mainland resulting in further sediment loads. Warming of the sea temperature during El Niño events in the last decade lead to coral bleaching and illnesses caused by bacteria.

The results indicate the strong need to develop a management plan for the region. A sustainable management strategy has to comprise physical measurements against soil erosion, e.g. agroforestry as an alternative land-use form, and anthropogenetic solutions like the development of ecological tourism in combination with a consequent environment policy. Only by conserving the marine resources the local population has a long-term economic and social basis to live on.

Keywords: Conservation of marine systems, coral reefs, Caribbean coast

Environmental Implications of Fuelwood Extraction and Gender Roles — Farmers’ Perception of Sustainable Forest Management in West Africa

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The demand for non-timber forest resources is at a scale that exceeds the sustainable yield of local forests. Consequently, alternatives such as crop residues and manure are increasingly used for fuel and thus depriving the land of the nutrients and the organic matter needed to maintain a good fertility status and regeneration in the soil. The dynamics of fuel wood extraction and the attendant environmental implications of gender roles are revisited using case studies from West African countries. Using participatory tools, farmers displayed an outstanding knowledge of natural environment and recognise the way forward in community empowerment through active involvement in management of forests. Reduced crop yields, lower rainfall, changes in cropping and grazing patterns and local spatial parameters were used as indicators of environmental degradation. Considerable attention is placed on the woman’s paradoxical roles as traditional custodian of the environment, hewers of fuel-wood and drawers of water juxtaposed with strong calls for environmental management and conservation. Irrespective of the merits of natural resource conservation, the overwhelming compulsion to rely on fuel-wood consumption especially in the third world nations remains a cause for concern.

Results show that farmers are aware of environmental degradation and the need to protect the environment, but this awareness could not be translated to positive actions due to lack of motivation, low capacity, weak resource base, intervention by government in traditional roles of communities through acquisition of traditional lands as forest reserves and lack of adequate information on coping strategies for increasing alternative energy needs. By far the greater threat to forest cover, the communities concluded, is human activity through exploitation for fuel wood, farming, roofing and building materials. The main thrust of this paper is the evaluation of the global concerns on natural resource conservation and management. It also dilates on an ex-ante assessment of the natural resource conservation including the conflicting and complementary roles of women in general. The gender contributions as roles attributed to the sexes by culture and nature in environmental management are reviewed with suggested ameliorative strategies.

Keywords: Environment, exploitation, gender, environmental conservation, deforestation, bio-diversity

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Where Are the Rainwaters?

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Despite the very high annual rainfall total in some tropical African countries, hunger due to the insufficient food production is still the order of the day. This provoked the question bothering on what is a happening to the high quantity of rainwater that comes from the often heavy rainfall.

An attempt to answer this question among others stimulates a field study of the surface runoff process and estimation in the Volta Basin, West Africa, which is one of the largest river basins in the tropics. Some runoff plots are constructed in one of the basins catchment called Kotokosu near Ejura, a major food production base in the transition zone of Ghana. The plots were constructed in a scaled dimension of 2 m×2 m, 2 m×6 m, 2 m×18 m, to also study the effect of scales on the runoff process. The catchment total runoff was monitored from a weir constructed at the outlet river equipped with automated depth recording instrument. Vegetation characteristic, soil physio-chemical properties were actively monitored and all other weather parameter were monitored in the rainfall season of the year 2002.

Results indicate that a very substantial part of the rains are lost in the surface runoff process due to poor soil infiltration properties, poor farming practice and untapped rainwater harvesting potential. These results were also used to validate a rainfall partition model that adequately divides the each rainfall events into, infiltration, deep percolation and surface storage, evapotranspiration and surface runoff depending on the soil slope, surface roughness, hydraulic conductivity, vegetation characteristics among others. The study concludes with suggested field management strategies that will improve efficient utilization of the abundant natural resources and enhance sustainable food production in the tropics.

Keywords: Rainfall, surface runoff, sustainable food production

Effect of Land Use on Soil N Dynamics at Watershed Scale in West Africa

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With demographic growth, land use in inland valley landscape in the humid zone of West Africa has recently been intensified. Bottomlands are opened for lowland rice cultivation while the adjacent slopes are increasingly being cleared for food crops. The extent of slope use is likely to intensify water and nitrogen fluxes and thus to differentially impact on soil fertility and crop productivity. A quantitative understanding of the water and N dynamics with intensified land use is hypothesized to improve the spatial targeting of technical options aiming at conserving soil fertility and maximizing water/nutrients use efficiency. A three-year study was conducted in a 130 hectare model watershed in the forest-savannah transition zone close to Bouake (Côte d'Ivoire). One half of the valley bottom was used for permanent lowland rice cultivation (8 ha). The land use of the slopes was gradually increased from natural vegetation in 2000 to 5 % (2001) and 10 % (2002) being converted into maize fields. Seasonal dynamics of soil moisture and water discharge as well as of mineral soil nitrogen and plant N uptake in the entire watershed were monitored. With the onset of the rainy season, a peak of soil N_{\min} of 70 kg N ha^{-1} was observed (Birch effect). The disappearance of nitrate N from the uplands coincided with a N_2O emission peak in the lowlands. This effect was most pronounced in newly opened land and its extent increased with the share of upland area cleared. By the onset of the main cropping period and the beginning uptake and immobilization of N in the biomass of crops, substantial amounts of soil N have been lost. Lowland rice does not seem to effectively use the early season influx of nitrate from cleared upland fields. Hence, the conservation of buffer strips of natural vegetation in the hydromorphic valley fringe to avoid nitrate seepage into the lowland and/or the use of pre-rice nitrate catch crops in the lowland to temporarily immobilize N in a growing biomass may enhance native soil N use efficiency. The effectiveness of various technical options under different land use scenarios will be discussed.

Keywords: Land use, N-dynamics, rice, West Africa

Applying the “Ecological Footprint Method” to Evaluate Beef Cattle Production Systems in Central-Brazil

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The work compares productive space appropriation efficiency for different cattle raising systems in central Brazil. Cattle industry is one of the major economical forces in the area. With a population of 11.5 million people and a herd of 56 million head, there is a growing debate about the environmental sustainability of the different production systems.

Environmental impacts are difficult to evaluate. A method called ecological footprint, evaluates the area of land needed to sustain the consumption and waste absorption for a given population. Consumption depends on production. In areas with high agricultural production and small population, like Central Brazil, the overall footprint balance would be positive. But in a smaller scale, comparing various production systems by relating their appropriated land area to their outputs, agricultural production systems may show large differences in relation to their environmental impacts, i.e. ecological footprints. The method here developed is a derivation of the original ecological footprint concept. It converts production inputs and waste absorption into land area and then analyses their efficiency by dividing total production by total land area appropriated. The method has the advantage of generating a single measuring unit, allowing direct comparisons among systems.

For this study, data was collected from two significant kinds of cattle systems in central Brazil: (1) extensive grazing on pastures; (2) intensive in feedlots. Results show that the grazing systems need 1.36 hectares to produce 100 kg of meat per year while the intensive systems need 0.40 hectares to produce the same amount of meat in a year. Although this kind of study does not specify where and how environmental impact happens, when considering rain forest devastation, it can be inferred that a system that is more efficient on land appropriation has better chances to be environmentally friendlier and become sustainable.

Keywords: Agricultural systems, beef cattle, Brazil, ecological footprint, intensification

Changes of Soil Properties and Input-Output Balance of Nutrients in Land-Use Systems Following Rain Forest Conversion in Central Sulawesi, Indonesia

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The rainforest area is declining rapidly in Indonesia with its nearly 50 % of Asia's and 10 % of the world remaining tropical rainforest. The most important factor for deforestation is agriculture. We wanted to study the sustainability of land-use systems in conversion areas in respect to soil fertility. We studied maize- and cacao/coffee-agroforests which are the main non-irrigated land-use systems of the upland rainforest margin areas of Central Sulawesi. The study objective of this study were:

- To quantify changes of soil properties under maize cultivation and agroforestry compared to natural forest and to measure the effect of the duration of cultivation (chronosequence).
- To measure the input-output balance of nutrients in maize and agroforestry compared to natural forest.

Soils were generally fertile, with high base cation saturation, cation exchange capacity and pH-values. Carbon and nitrogen-stocks were highest in natural forest and lower in maize and agroforestry. In maize both C and N decreased with time, whereas in agroforestry they increased slightly. Maize fields had lost on average approximately 25 % of the below-ground C-pool compared to natural forest. Soil bulk-density was highest in agroforestry, in maize an increase was observed in time and in agroforestry it remained stable on a high level. In both managed systems Ca-saturation of CEC increased and K-saturation decreased during cultivation. We measured nutrient-input by precipitation, and output by leaching and harvest export on unfertilized maize- and agroforestry-sites. We found low nutrient input through rain, only potassium was imported in considerable amounts. Exports of Mg, Ca was mainly by leaching, whereas N and K was exported mainly by removal of crop harvest. Highest nutrient exports were found in the agroforestry system, maize was intermediate and lowest were found in the forest sites. All systems, including the forest sites, had negative balance of macronutrients, indicating open nutrient cycles on these soils even in natural forests.

Keywords: Chronosequence, land use systems, rain-forest conversion, soil fertility, soil nutrients

Soil Fertility Conservation for Sustainable Agriculture in Sloping Lands by Applying Appropriate Crop Systems and Green Manure Crops in Mountainous Area of Northern Vietnam

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Vietnam is facing the deterioration of upland sloping lands caused by a long history of man's activities, which have led to soil erosion, leaching, and an unfavourable environment. Sloping lands in Vietnam occupy about 75 % of the total territory and play an important role in the socio-economy and environment of the whole country, affecting the lives of 24 million minority people. Most of sloping lands in Vietnam are affected by erosion and leaching in the course of deforestation for annual crop cultivation without application of soil conservation measures. Soil degradation is indicated by the following: the degradation of soil physical properties such as high soil compaction, poor structure, low water infiltration, low soil organic content, low CEC, high phosphorus fixation.

Shifting cultivation is a common practice in these areas, especially by poor ethnic minority people. The study showed that the Tay people have two main forms of agricultural practices: paddy rice cultivation on wet land and swidden on sloping land. Swidden practices have caused high levels of erosion and leaching of nutrient elements. There is thus a threat of decline in soil fertility and ultimate degradation of agricultural sustainability.

The amount of soil lost is not as great as previous research has suggested, even in monoculture terraces. It varied from about 48 ton/ha-year (on 1 year swiddens) to 58.27 ton/ha-year (on 4 year swiddens) and only 3.69 ton/ha-year (on Agroforestry with Mulch). Establishment of hedges from *Tephrocia candida* and *Leuceana glauca* places a possibility for the reduction soil erosion.

Nutrient levels decline very quickly after the fourth cultivated year, especially with regard to cations. Thus CEC and base saturation levels are low. The yield reduction, especially of maize, is accelerated with successive cultivation. In addition, weeds grow up very quickly, so the plots became abandoned for natural regeneration. Finding solutions for a sustainable development of agriculture on sloping land is an urgent requirement in Vietnam. From the result, the author gives solutions for sustainable agricultural development as well as for environmental protection for upland areas of Vietnam.

Keywords: Shifting cultivation, soil erosion, problems of land use in Vietnam, sustainable land use

Multiple-Resource Inventory in Degraded *Acacia mangium* Stands as a Basis for Planning Forest Rehabilitation in Malaysia

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From 1981 to 1992 the “Compensatory Forest Plantation Projects” were carried out in four states of Peninsular Malaysia. The objective was to supply the Malaysian timber industry with quality sawlogs once the resources from natural forests are becoming scarce. The projects were financed by the Malaysian government and through a loan of the Asian Development Bank. Throughout eleven years of reforestation about 50,200 ha of logged over natural forests have been replanted with fast growing pioneer species, mainly *Acacia mangium* WILLD. (over 90 % of the area). The program was phased out in 1992 because results in terms of growth and quality have not been satisfactory.

Under the auspices of a Public-Private-Partnership, the Chair of World Forestry / University of Hamburg collaborates with a German company in Malaysia, in order to rehabilitate 4,700 ha of those degraded *Acacia mangium* stands on a 60 years concession basis. A first growing stock and site assessment was carried out with the objective of evaluating the stand and site quality 10 to 15 years after planting. Moreover, a decision was needed if the stands show potentials for further silvicultural activities through, e.g. enrichment planting or if they have to be replaced totally.

A post-inventory-stratification was carried out and subdivided the area into productive *Acacia mangium* stands (65 %) and unproductive semi-natural stands (35 %). With a growing stock of 175 m³/ha on the productive parts, 15 year old *Acacia* stands achieved a mean annual increment of 12.2 m³/ha·yr and thus remained far below the former expectations of approx. 20 m³/ha·yr. Furthermore only 20 % of the timber has the potential to be used as sawlogs due to severe heartrot. The site quality assessment provided a possible explanation for the low stand qualities: phosphorus levels were below limit of detection and very low values of exchangeable K, Mg, and Ca have been found. Only the C/N ratio of 7.3 was within a range suitable for plant growth. The rehabilitation of the stands is now carried out with an appropriate silvicultural concept combining natural regeneration and replanting with fast growing and natural forest species.

Keywords: *Acacia mangium*, inventory, Malaysia, plantation, reforestation

Degradation of Natural Resources or Necessary Intensification of Land Use to Sustain a Growing Number of Users? — The Case of the Zamfara Forest Reserve in Northwest Nigeria

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The rural Zamfara Forest Reserve is an important grazing area for the livestock of transhumant pastoralists and the sedentary population living in the four designated farming enclaves and in bordering villages. Both farm sizes and the farmers' livestock holdings are larger than in intensified, densely populated systems where cropland scarcity and the diminution of common rangeland are driving land use intensification. Nevertheless, the farmers in the enclaves have developed a sustainable soil fertility management. But there is increasing human pressure on the communal grazing land, which stems from cropland encroachment, the immigration of landless farmers and intensive grazing, with an average annual stocking rate of 0.73 TLU ha⁻¹ on the rangeland. A comparative analysis of vegetation density between 1962 and 1991, it is estimated that 71 % to 85 % of the vegetation and 50 % of the trees had been removed. The present paper examines if the reserve is on the verge of irreversible land degradation like these figures suggest, or if it is sustaining the livelihoods of increasing numbers of farmers and livestock-keepers at low but sustainable levels?

Thus, the change in land use/land cover is being analysed using CORONA images (1965), a Landsat 7 ETM+ (1999) classification and GPS referenced data on vegetation structure. Vegetation structure as ground truthing for the classification and data on the human population and livestock numbers in the enclaves were collected from February to May 2003.

The cropland surface cover increased from 1.2 % (1965) to 8.3 % with agricultural encroachment from outside the reserve accounting for 64 % of cropland areas (1999). The results of the land cover classification contest negative incremental change, as 80 % of the reserve are still covered by tree and shrub savannah. These findings are going to be verified with the field data and compared to other research results to examine if there is evidence of land use intensification in the enclaves. The paper will then describe the development of human and livestock population and discuss the data's feasibility to support or reject the degradation scenario.

Keywords: Land use/Land cover change, Nigeria, resource assessment

Succession, Biomass Development and Nutrient Dynamics in Traditional Shifting Cultivation Systems of Central Sulawesi, Indonesia

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Shifting cultivation was the most practical approach evolved by farmers in the Tropics to inhibit weed infestation and decline of soil fertility after a period of cropping. Farmers of the village Katu, Central Sulawesi, still practice shifting cultivation with short cropping and long fallow periods, an overall opportunity to study the sustainability of this sequential agroforestry land use system. Therefore, on natural fallows of 1 to 7 years (false time series) the successional changes of vegetation were determined and biomass development, nutrient accumulation of distinct life forms and soil nutrient dynamics were studied. The vegetation was grouped into grasses, herbs, shrubs and trees. Fresh and dry weight of each group, along with root biomass, were recorded. Plant specimens and soil samples were also collected. At the species level, 117 of 218 plant samples were identified. Rapid increase (up to 7.8 t ha⁻¹) in total biomass was recorded in the first 2 fallow years, which was dominated by grasses and herbs. By fifth year, biomass was at 11 t ha⁻¹. But, the composition of vegetation has now changed with trees dominating. By seventh year, biomass reached 45 t ha⁻¹ and trees were >5 m height. Over time, root biomass (0–30 cm topsoil) reduced from 16 to 8 t ha⁻¹. During the course of fallow development, there was no significant change in the levels of P, K, and Mg stored in the vegetation. Average amounts were about 8.8 kg P/ha, 68 kg K/ha and 5.3 kg Mg/ha. At the same time, the accumulated N and Ca levels increased from 48 and 30 kg/ha to 70 and 80 kg/ha, respectively. There was a continuous decline in CEC_{eff} as well as K, Ca and Mg stocks while P remained constant and no clear trend was found in soil pH. In the context of Central Sulawesi, trees play a crucial role in maintaining the production potential of traditional shifting cultivation systems. They recycle leached nutrients, tap new nutrient stocks from deeper soil layers and build a nutrient pool for the following cropping period. Trees best serve as indicators of sufficient fallow length.

Keywords: Agroforestry, biomass development, nutrient dynamics, shifting cultivation, sustainability

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Maintaining the Yield of Upland Rice under Intensified Land Use in Slash and Burn Systems of West Africa

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Most upland rice in West Africa is produced in slash-and-burn systems of the humid forest zone. With increasing land shortages, the length of fallow between periods of cultivation has declined from 12 years in the 1980s to less than three years at present, with permanent cultivation emerging in some high population areas. Land use intensification in these low-input systems results in declining yield levels, which are associated with a reduced soil N supplying capacity, more weed pressure and widespread P deficiency on the predominant acid Ulisols. Low-cost options potentially available to farmers may include (1) the use of weed-suppressing nitrogen-fixing legumes that replace the traditional weedy fallow, (2) application of locally available rock phosphate, and (3) the use of input-responsive weed-suppressing rice cultivars. These options, solely and in combination, were evaluated in a 3-year field experiment near the town of Gagnoa in the bimodal forest zone of Côte d'Ivoire.

Permanent cultivation of the same field reduced upland rice yields from 3.0 Mg ha⁻¹ in the first year after clearing a 12 year-old bush fallow, over 1.6 in year two to 0.7 Mg ha⁻¹ in the third year of cropping. Replacing the off-season weedy fallow by a planted fallow of pigeon pea (*Cajanus cajan* L.) was able to slow the yield decline and to reduce the weed biomass in rice. Rock phosphate at a rate of 30 kg P ha⁻¹ increased upland rice yield only, when applied to a legume fallow. Modern varieties responded to improved management (legumes+ P) but succumbed to the weed pressure under traditional management. Combining legume fallow with rock-P and the use of an interspecific cross of *Oryza sativa* × *O. glaberrima* maintained the yield of upland rice at more than 2 Mg ha⁻¹, even in the third year of cultivation.

Keywords: *Cajanus cajan*, Côte d'Ivoire, *Oryza sativa*, rock phosphate, weeds

Land Use, Farming Systems and Carbon Sequestration in Ouémé Catchment in Benin

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Main goal of this study was to analyse the influence of farming and land use systems on the carbon sequestration and food security in upper Ouémé catchment in Benin. The study was conducted in two representative villages: Dogue and Sérou respectively for villages with and without land to clear.

Farming systems in the upper Ouémé catchment are mainly shifting cultivation. The crops are sown principally from May to August and the yam comes at the head of crop rotation: tuber (yam) – cereal – cotton or cereal – leguminous – cereal or cotton – cereal – fallow or cashew. Except yam, other food crops are intercropped and the number of intercropped crops increases with land scarcity. Farming systems are also still characterised by the growing of cashew plantations, which can provide a solution to deforestation.

On the assumptions, that the rainy season ends in September instead of mid-October, the quantity of rain and the farming systems remain unchanged, the soil productivity and rainwater use efficiency will decrease respectively to 17 and 23 % in Dogué, to 14 and 25 % in Sérou. The seasonal rain variability in Dogué and Sérou could lead to the peoples' migrations (5.5 %), deforestation (2.6 %), carbon release (77 t/ha and 3 t/inhabitant CO₂) and increase of agricultural water use (from 1357 to 1756 and from 2562 to 3422 m³/inhabitant-year respectively in Dogué and Sérou).

Biomass burning and increase of agricultural areas are two principal factors that cause the release of carbon into the atmosphere. The carbon sequestration is higher in forest (70.9–135.0 t/ha) than in other land use system. The difference between the forest system and the agricultural areas (38-103.4 t/ha) represents the carbon emission.

Summary, farmers in upper Ouémé catchment need efficient water use management to achieve their food security, otherwise they are obliged to extend their agricultural areas or to immigrate towards less occupied regions. Consequently the carbon release, which accelerate the climate change, will increase.

Keywords: Benin, biomass, carbon emission, carbon sequestration, farming systems, food security, land use

Land Cover Analysis and Afforestation Options for Mitigation of Climate Change in the Lowlands of Bolivia

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Land use in South and Central America is still very dynamic. While in many regions deforestation is ongoing, in others the abandonment of pasture land is prevailing. Conversion of these lands into forests may have a series of beneficial effects, for the natural resources (such as water, soil, biodiversity), but also from a socio-economic point of view. Potential income from carbon sequestration may serve as an additional stimulus for land owners to systematically convert those lands into forest.

The present study focuses on an evaluation of the overall potential of afforestation projects for carbon sequestration, in the Region of *Buena Vista* in Bolivia.

Satellite image analysis was carried out in order to locate best sites for carbon sequestration. Land use analysis revealed that the area suitable for conversion of pastures into plantations was about 9,800 ha. Plantations of Serebo (*Schizolobium amazonicum*) were considered and biomass estimations taken in 10 plantations of different ages.

With that information, a cost benefit analysis was performed to identify the conditions under which landowners may change their pasture lands into plantations, benefiting from future payment for carbon sequestration. In order to calculate opportunity costs, the net present values of two land uses were compared (cattle ranching and forest plantations).

The study shows that, in the absence payment for carbon sequestration, plantations of Serebo are not competitive compared to cattle ranching. Assuming a forest stand that produces both timber and carbon, the net income of a plantation of Serebo is higher than the net income from cattle ranching in the region.

Keywords: Biomass, carbon sequestration, cost-benefit analysis, land cover analysis

Land Cover Dynamics and Climate Variability in Côte d'Ivoire as Crucial Determinants for Agriculture and Biodiversity

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Especially in climate sensitive regions, where irrigated agriculture is the main source of food security and income, concerns about the variability in rainfall, its temporal and spatial distribution, must be taken very seriously. This seems to be particularly true of West Africa where e.g. significant alterations in precipitation during the great Sahelian drought of the early 1970s and 1980s affected several countries.

In Côte d'Ivoire (Ivory Coast) essential anthropogenically induced land cover changes took place during the past five decades. At the same time, the country suffered from a rainfall deficit at least for the last three decades. The environmental impact on the Ivorian socio-economy and natural biodiversity, however, remains ambiguous. In frame of the BIOTA-West Africa scientific research network funded by the German Ministry for Science and Education (BMBF) a multi-scale monitoring concept was designed, combining most suitable and advantageous features of remote sensing and bioclimatic ground observations in order to examine the following focal points: (i) monitoring of large scale vegetation dynamics, (ii) change detection of vegetation and land surface characteristics (particularly human induced changes of different degradation intensity), and (iii) the importance of changes within biosphere – atmosphere interactions. Results of this paper support the idea that regional variability in precipitation is considerably linked to significant changes in vegetation cover. Furthermore, the analysis of remote sensing and ground observation data revealed that a strong decrease of monthly amounts of precipitation, as observed during the extraordinary El Niño event of the years 1982–83, led to a pronounced response of the vegetation in southern and northern Côte d'Ivoire. Among other authors we conclude that besides variations in sea surface temperatures (SST) and anomalies of the Intertropical Convergence Zone (ITCZ) also the impact of ENSO events may affect circulation patterns in West Africa via oceanic-atmospheric teleconnections.

Keywords: BIOTA-West Africa, climate variability, El Niño, Ivory Coast, land cover changes, NDVI, vegetation dynamics

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Sea Level Rise Affecting Hydrology and Rice Production in the Vietnamese Mekong Delta

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In this study, we assessed the impact of sea level rise, one of the most ascertained consequences of global climate change, for water levels in the Mekong Delta. We used a hydraulic model to compute water levels (in relation to sea level) from August to November – when flooding can already be critical under present conditions— under sea level rise scenarios of 20 cm (= SLR 20 cm) and 45 cm (= SLR 45 cm), respectively. The contour lines of water levels are shifted up to 40 km towards the sea by higher sea levels. At the onset of the flood season (August), the average increment in water levels in the Delta is 14.1 cm (SLR 20 cm) and 32.2 cm (SLR 45 cm), respectively. High water discharge from the river system attenuates the incremental changes in water levels at the peak of the flood season (October), but average water elevations of 11.9 cm (SLR 20 cm) and 27.4 cm (SLR 45 cm), respectively, still imply a substantial aggravation of flooding problems in the Delta. GIS techniques are used to assess vulnerability in three categories, i.e. areas with high (2.3 mio ha = 60 % of the Delta), medium (0.6 mio ha = 15 %) and low (1 mio ha = 25 %) vulnerability to sea level rise. Rice production will be affected through excessive flooding (in the tidally inundated areas) and longer flooding periods (in the central parts). These adverse impacts could affect all three cropping seasons in the Delta as long as no preventive measures are taken.

Keywords: Cropping pattern, GIS, land use, model, season, tide, vulnerability, water level

Mobile Pastoralism in the South of Morocco — Present Crisis and Perspectives for the Future

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Changes in the socio-economic framework as well as population pressure have caused fundamental upheavals in land-use in the arid South of Morocco, thus provoking a crisis of the traditional mobile pastoral system. Formerly, mobile pastoralism represented an ecologically and economically stable form of land-use on common lands. Due to continuously increasing cropping activities, pastoral areas have become more and more restricted to less fertile lands. This tendency is aggravated by the fact that the nomadic pastoral management tradition has all but disappeared and new pastoral management systems have not yet developed. All these factors have led to an increased pressure on collective land causing degradation of the pastoral land and resulting in serious social conflicts as well as ‘social erosion’ processes.

Governmental policy and subsidies as well as severe droughts have accelerated these developments and further increased the gravity of the situation. It must be noted that pastoralists in Morocco do not have effective leadership and are largely excluded from governmental or donor projects.

Under these conditions, one section of the mobile pastoralists can no longer assure household survival through income from animal production and thus impoverishes rapidly. As a response, this group often settles in peri-urban areas provoking new land-use conflicts. A second group of pastoralists becomes increasingly commercialised. Using collective pastoral lands as livestock ‘parking lots’ they supplement feeds and add concentrates. After rainfall events herds may be transported to regions up to 1000 km away.

The establishment of associations for mobile pastoralists in different communes could be one option for the future. Services like veterinary service, extension or mobile schools could be financed by contributions of members based on the number of livestock kept within the association area. Thus, the risk of over attractiveness of these services for mobile pastoralists and the resulting overgrazing of the communal land could be reduced. With the help of sound extension work awareness of the limitations of pasture resources could be created. Land users may accept the fact that degradation of pastoral lands is related to high external costs.

Keywords: Collective lands, land use conflicts, Morocco, pastoralism

Land Preparation with Mulch Technology in the Eastern Amazon — The Hydrological Perspective

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Agriculture in the “zona Bragantina” of Northeastern Brazil has been based on slash-and-burn shifting cultivation for more than 130 years. With the increase of pressure on this agricultural land-use system, management techniques such as mulching and change of cropping system have been proposed as alternatives by the German-Brazilian SHIFT project. The research objective of this sub-project is to determine which changes may occur in the water and nutrient balance at a watershed level with the implementation of mulch- technology.

Mulching in general will decrease nutrient losses to the atmosphere and overland flow, and improve the dry season soil moisture condition. These positive effects are thought to be partially offset by increased leaching and irretrievable loss through groundwater and sub-surface water movement.

Field measurements were performed from August 2000 till July 2002 at two first order tributaries of the Cumaru watershed, located 12 km southeast of the town Igarapé-Açú, and 110 km northeast of Belém, Brazil. Throughout the study period a high-resolution database was assembled. The first watershed was monitored for one year after which the land was prepared with the bush chopper. In the second watershed the traditional system was maintained throughout the entire period. The spatial database contains information on topography (Digital Elevation Model), land use, vegetation, and soils. The hydrological database contains micro-meteorological, soil moisture and runoff data at a 5-minute interval, and daily measurements of groundwater levels at 80 observation wells. Stream, ground, and rain water were sampled at regular intervals and analyzed for all main macro-nutrients. Infiltration and spatially distributed soil moisture measurements were performed for selected fields within the watershed.

The benefits of mulching over traditional slash-and-burn agriculture are strongest on a field level. Moisture and temperature conditions improve considerably, and nutrient losses due to leaching are minimal. At a watershed level though, the benefits will only be significant with a further land use intensification.

Keywords: Hydrology, mulch, nutrients, secondary vegetation, water

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Integrated Land Use Assessment and Monitoring

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It is impossible to achieve sustainable development without a secure and lasting supply of food, nutrients, medicines and fibre from the land. Furthermore, sustainable development implies that environmental services — such as biodiversity, soil and water conservation, and climate regulation — are maintained or improved. From a national policy perspective, it is also necessary to include ownership, governance, equity, trade, and contributions to the overall economy in the equation. It is therefore logical to approach sustainable land management as a multiple-goal planning problem, where a large number of objectives are to be addressed. A key factor for policy development and monitoring is then access to reliable, relevant and cost-effective land use information. For this purpose, FAO develops an approach to support national assessments and monitoring of land use, based on nation-wide field sampling. The information produced is reliable thanks to a representative statistical design. It is relevant because parameters cover biophysical resources, management regimes, uses/benefits, as well as user categories in the local scale, and thus provide a broad and holistic view of land use for the country as a whole. It is cost-effective because a small but representative sample can generate sufficiently detailed knowledge at the national level. Permanent sample locations and commitments by national institutions are expected to secure long-term monitoring. By integrating the assessment and monitoring across forest and agriculture sectors, possibilities are created for analysing land management as a whole. For example, conflicting objectives between sectors – such as subsidies to agriculture vs. efforts to reduce deforestation, may be analytically weighted against each other. Examples and experiences of field implementation are presented in the paper.

Keywords: Land use assessment, modelling, national forest assessment

Modelling Land Use Change in Northern Ghana

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The Volta Basin in West Africa drains about 400,000 km² area of land, including 70 % of mainland Ghana. Low rainfall reliability and water insecurity, high population growth rate and macroeconomic transformation in the last few decades have had a profound influence on livelihood strategies of the largely rural populace. Therefore, many parts of the basin are “hotspots” of land use / land cover change (LUCC). The determinants of LUCC in an area within the Volta Basin of Ghana were identified using multiscale, spatial statistical analyses. Land cover change trajectories were defined using multitemporal Landsat TM images acquired over a 15-year period. Training signatures for land cover classification using maximum likelihood algorithm were developed based on PCA, tassel cap and NDVI transforms, while ground truth data were obtained from aerial photo interpretation, field visits and topographic maps. Change detection was based on synergy between image-differencing and post classification. Statistical relationships between land cover and selected biophysical and socio-economic variables were determined at different cell resolutions ranging from 30 m to 1050 m using generalized linear mixed model technique, which also allows incorporation of spatial correlation in the analysis. The results indicated the scale-dependency of LUCC patterns in the study area. There was a drastic conversion of woodland to agricultural land and a general transition to less vegetation cover. Spatial statistical model also revealed that driving factors of land use change could be related to well-established land use paradigms. Thus, the model could be used to support land use planning and other environmental management decision-making in the study area.

Keywords: Land use change, spatial model, environmental management

GIS-Landscape Modelling of a Regional Green Corridor in Tropical Argentina

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The landscape pattern of an agricultural area has been modelled. Landscape modelling is based on landscape theory. Land use is classified according to administrative, homogeneous and functional criteria. The farm area defines the minimal administrative unit. The landscape unit and the agricultural field defines the homogeneous land unit. A spatial functional hierarchy is established. The landscape pattern is modelled and analysed through the geographical information systems (GIS). Remote sensing and participatory information provide basic information. Spatial scale analysis ranges from field to regional level. The approach is validated through a study case.

In Misiones, Argentina a “Green Corridor” project was created by law in 1999. The corridor covers 20 % of the provincial area. It should connect 15 of 48 protected areas, preserve natural ecosystems and increase tourism. The ecosystem potential for nature conservation is analysed in the Guacurá District, located in the Northeast of the Misiones Province. Ecological indicators (connectivity, fragmentation and variegation, among others) are calculated. The results show that connectivity between protected areas does not increase substantially. Natural ecosystems covers the area partially. The native forest is insular and variegated. It shows narrow interior space, high edge effect and partial corridor arrangement. Accordingly, more successful projects should concentrate on: designing and conserving local corridors, encouraging soil protection techniques and promoting individual “alternative activities” as well as nature conservation efforts.

The methodology allows ecological analysis of farming systems and land use down to the farm level. The relationship between agricultural and conservation land use is precisely quantified. The presentation of analysis and results is flexible and can be modified easily and without affecting accuracy. The methodology can be applied for regional land use evaluation with local accuracy and as a communication tool for participatory project analysis.

Keywords: Argentina, GIS, green corridor, landscape analysis, remote sensing

Linking Land Use / Land Cover Changes with Socio Economic Data to Set up Scenarios for a Sustainable Development Plan

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In many areas in Africa there are fast changes of the land use /land cover. For a sustainable land management it is important to have information about the spatial patterns and the speed of the changes. As well there must be an sound understanding of the underlying processes and actors of the LUCC. Based on that information it is possible to set up scenarios for future development and estimate the impact of development measures like building roads on the land use /land cover.

This paper presents recent work which is done in the semi-humid tropics in Benin. The area of investigation is the catchment of the Upper Ouémé in Benin which has an area of around 100 km × 100 km. In the last decades there are strong changes of the LUCC due to growth of the population, migration and logging activities. The pattern and the speed of the LUCC where derived by analysing multi-temporal LANDSAT TM and ETM images taken since 1986 up to now. Assessing the anthropogenic LUCC in the semi humid tropic is not an easy task. The problem is to differ human long term changes from the natural changes in vegetation due to the change of wet and dry season or the impact of bush fire. Using advanced change detection methods like change vector overcame that problem.

To identify the driving forces and the actors of the therewith derived LUCC the change patterns were linked with socio-economic data. Official census data supplemented with own, more detailed, census served as input. With comprehensive GIS and statistical analyses it was possible to build up a regional model to describe the LUCC for the test area. With this model scenarios for future development under different boundary conditions can be computed. This is an important step for the set up of a sustainable landscape management plan.

Keywords: Benin, change detection, land use and land cover change, modelling, remote sensing, West Africa

Modelling the Development of Natural Pasture and its Sustainable Use

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This paper reflects on a growing opportunity of interdisciplinary collaboration across ecological and economic sciences towards the dynamic modelling of complex ecological economic interactions. It uses rangelands as an example. The importance of interdisciplinarity in natural pasture research is highlighted, as most natural rangeland problems involve the interaction between social and ecological forces. Causes for overuse are identified as misperceived behaviour of farms and households, and the consequences can be measured in terms of changing production potential of rangelands. Therefore feed back effects, running in both directions, have to be considered. The paper considers two different developments: those based on perceptions from rangeland system ecology, and those based on the inclusion of vegetation dynamics in models of rangeland utilisation. The first one includes models simulating complex vegetation dynamics by cellular automata and Markov chains. The second comprises on growing sets of models dealing with links between economy and biology. Normally, the links can be found as bio-economic rangeland models. Models are characterised by the fact that the economic optimisation problem is constraint by the vegetation dynamics of the natural pasture being exploited. The paper discusses two different approaches and provides related simulations. Possible future developments of natural pastures as sensible to a variable economic framework and the impacts of climate change are highlighted.

Furthermore, the paper shows innovations in modelling on discontinuous and more event-driven responses to semi-arid vegetation, in particular with respect to utilisation rates. In a case study on central Namibian rangelands we focus on bush encroachment and pasture quality. Within a typical optimal control approach in dynamic programming, a state-and-transition matrix serves as an interface to relate the biological system to the economic system, i.e. market prices and institutional constraints. As a useful by-product of this attempt one can derive shadow prices for scarce natural resources which can be regarded as an internal valuation of the environment. Thereby, the resource quality is referred to as state variables within a multi-equilibrium system. Finally, this paper describes possible suggestions for environmental policy to sustain natural pastures as derived from the different modelling approaches.

Keywords: Bio-economic, cellular automata, environmental policy, models, rangeland, state-and-transition

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Site Index Curves for Five Pine Species in El Salto, Durango, Mexico

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Forest productivity is a key component in classifying forest stands for the sustainable management of forests. For most species, height growth is independent of stocking over a fairly wide range of stand density, thus is often used as a measure of site productivity. In this study, we tested six site index functions for five commercial pine species of the forest region of El Salto, Durango in Mexico. The species investigated in this work were *Pinus cooperi* var *ornelasi* MARTÍNEZ, *Pinus durangensis* MARTÍNEZ, *Pinus engelmannii* CARR, *Pinus leiophylla* SCHL ET CHAM and *Pinus herrerae* MARTÍNEZ. Height growth functions were fitted for individual species and all species based on stem analysis data. The correlation coefficient and the root mean square error were used as criteria for evaluating the functions and finally selecting the best equation for the construction of the site index curves. A residual analysis was done for detecting dependencies and discrepancies of the patterns of curves. Among the six height growth models used, the special polymorphic formulation of the HOSSFELD function proposed by CIEZEWSKI and BELLA (1989) gave the best accuracy and precision for four out of the five pine species. SLOBODA'S function showed a slightly better performance for the one remaining species. Based on the analysis, the CIEZEWSKI and BELLA'S polymorphic function can be recommended for all the five species. The proposed function has fewer coefficients than the previously developed CHAPMAN-RICHARDS' model used for the major tree species in this forest region, and is able to provide compatible site index curves as well as height growth.

Keywords: Durango, El Salto, Mexico, *Pinus*, site index function

The Potential of Research on Gradients to Explain the Pattern of Differences in Regional Socio-Economic Development — An Example from the Mai Son District, Northern Vietnam

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The spatial diversity of natural conditions, along with ethnic and cultural distinctions within the rural population, contributes to the diversity of farming systems and determines differences in economic development. Particularly in mountainous regions, changes in conditions may be described along transects by models of altitudinal, socio-economic gradients. The potentials of such spatial models for the generalization of findings about successions in development conditions depend on the significance of relations between physical factors of the environment and the social and economic situation of people in the respective locations. Results of a research programme on the interaction between social and elevation gradients in a mountainous district of Northern Vietnam indicated the value of the modelling approach for a spatial gradation for development. Most types of family resources tended to become increasingly disadvantageous along the gradient from the valley, where access to urban structures is provided, up to the remote mountainous areas. Examples for this general tendency are the education level of family members, which decreases along the gradient while family size increases, and land resources, which tend to get larger along this line but show a decrease in soil quality and nutrients. Simultaneously, ethnic compositions change from a majority of Kinh people to a predominance of descendants from the Black Thai and H'mong tribes. The differentiation of the resources combined with the differentiation of infrastructure and services led to respective differences in the economic success of farms and families. Family income, for example, decreased from annually 1536 US\$ for families in the valley (Bac Quang village) down to 534 US\$ for families in high mountainous areas (Pa Dong village). Assessment of further criteria of living standard showed a similar, significant linkage between ascending terrain and descending economic situation of the population. The results support the assumption that altitudinal gradients have a high explanatory value for trends in economic development of mountainous areas in tropical and subtropical countries. Incorporating gradients in spatial analyses and planning of resource use and socio-economic development has thus the potential to reduce the required input for data collection and to improve the prediction of probable impacts from changes.

Keywords: Living standard, socio-altitudinal gradients, spatial modelling, Vietnam

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Remote Sensing Based Mapping of Land Use Systems and Land Cover Change in the Rain Forest Margin of Central Sulawesi

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The SFB-552 “Stability of rainforest margins” examines the processes of destabilisation at the forest border and analyses factors and processes that may conserve forest systems. Within this framework, remote sensing data analysis provides a spatial coverage of the landscape pattern. Earth observing satellite sensors are able to deliver spatial and temporal data for the assessment and observation of land use change at the rain forest margin.

At the Institute of Geography, processing and analysis techniques are evaluated and developed to supply a reliable and operational processing chain for the exploitation of (optical) remote sensing data and to monitor land use and cover change (LUCC) in tropical regions. One aspect of the ongoing research is the routinely land cover classification at the regional scale based on Landsat-data. A time series ranging from 1972 to 2002 is available for the project area. Landsat-data analysis is a well known procedure but has also often shown to be limited by the number of land use units that can be differentiated. The diversity of land use systems in the tropics and the resulting variability of the physiognomy of annual and perennial crops constitutes a problem in the classification process of optical remote sensing data. In most cases, only one data take per year is available and thus the temporal dynamic and spectral behaviour of land use types can not be detected successfully by the use of conventional (pixel-based) classification techniques.

For this reason, additional information has to be considered during the classification process. This is done by a context-based method that integrates spatial properties (shape, distance, location) of the objects and their relations as well as historical data and logical functions in the classification process. The result is an improved thematic map showing the status and the changes in the distribution of the major land cover types within the past 30 years for the Lore Lindu National Park area and its surroundings. Thus, the work presents a basis for socio-economical and ecological analysis and modelling of land use scenarios within the SFB.

Keywords: Land cover, land use change, rain forest, remote sensing

Beef Cattle Composition Simulation — Model Development and Evaluation

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Body composition simulation is an important component of beef production models. Empty body fat percentage (EBF%) and empty body weight (EBW) are the most changeable and relevant variables to simulate. Estimations of steers EBF% allow predicting sale timing and grade. EBF% of dams relates to reproductive efficiency, which mainly determines animal productivity in cow-calf systems. Additionally, the number of input variables required by this animal model should be kept at a minimum to allow a correct integration in the beef production model. The objective of this work is to develop a model that simulates EBW growth and composition, from a description of the animal and feed consumed which do not differ from most existing feeding standards. The proposed model is based in three main assumptions. First, animal growth is driven only by energy intake. Second, EBW is comprised by three components: (1) fat free matter (FFM); (2) normal fat (fatty tissue for moderate fatness); and, (3) excess fat (additional fatty tissue). Each EBW component has a given potential growth curve determined by the frame score and sex of the animal. The third assumption relates to the priority of accretion and mobilization of components. In the proposed model resources are allocated firstly to build up FFM; secondly to increase normal fat; and, lastly to accrue excess fat. Mobilization occurs following this priority scheme when resources do not allow meeting maintenance requirements. Published results were used for model evaluation. These cases comprise females, steers, and entire males, and with feeding regimes from low (next to maintenance) to high (ad libitum) energy intakes. The difference (D) expressed as a percentage ($|\text{observed} - \text{estimated}| / \text{observed} * 100$) was used as the accuracy indicator. EBW was estimated accurately within the whole range of cases (D: 5.8%; N = 71). Accuracy of EBF% prediction was lower (D = 27.5%; N = 59) than EBW estimations. Level of accuracy demanded by the whole beef production model where the animal model is integrated should be established before estimates are assessed as accurate or not. However, preliminary analysis indicates that EBF% accuracy should be improved or body composition proxy changed before integration is performed.

Keywords: Animal growth simulation, body composition, empty body fat, empty body weight

A Land Resource Database for the Republic of Niger to Estimate Topsoil Losses through Wind Erosion at the Regional Scale

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Arid and semiarid regions like the Republic of Niger are most prone to soil losses by wind erosion. In the last decades, the decreasing vegetation cover in the semi-arid part of Niger Republic increased the risk of soil erosion. The decline is partly due to decreasing rainfall, but more important is the expansion of cropland. The wind erosion potential is variable, depending on soil cover, land use, soil moisture and soil surface type and has been described only qualitatively at the regional scale.

Thus, in order to assess wind erosion at the regional scale, a geographical information system on the relevant surface properties in the Republic of Niger has been generated for regional modelling, following the conceptual basis of the SOTER approach (ISRIC 1993) and the World Reference Base of Soil Resources (FAO/ISRIC 1998), including the following spatial layers:

1. Land cover and soil surface types based on analysis of remote sensing data (LANDSAT, AVHRR/NDVI) from transects covering arid to semiarid areas in Niger
2. Geological map of Niger Republic
3. Soil map of the world covering the entire Republic of Niger
4. Detailed soil maps of the intensively used Southern part of Niger Republic
5. Digital elevation model (GTOPO 30).

Through the combination of the surface data sets with climatic data, realistic modelling of the dust emission rates in space and time can be performed. Maps on the wind erosion potential for different land use scenarios in Niger Republic will be presented.

Keywords: Land resources database, land use scenarios, Niger Republic, wind erosion

Using the Cropping Systems Model APSIM to Assess Sowing Strategies for Faba Bean Infested with the Parasitic Weed *Orobanche crenata* — A Simulation Study

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The angiosperm root parasite *Orobanche crenata* inflicts considerable damage on the production of grain legumes such as faba bean, lentil and pea, in Mediterranean countries. Numerous counter measures have been tested, but no single method proved to be both effective and practicable on its own. It has therefore been suggested that *O. crenata* can only be controlled by an integrated strategy combining several methods.

Delayed sowing of host crops is a potential element of *O. crenata* control strategies, as it has traditionally been known and been experimentally confirmed as a means to reduce *O. crenata* parasitism. However, experimental results cannot be simply extrapolated to other, not yet studied, field situations, as factors determining the behaviour of the host-parasite system, namely weather conditions, cultivar properties and parasite soil seed bank, vary between locations and seasons. An experimental evaluation of all possible sowing strategies would be highly labour- and time-consuming, yet results would be site-specific. A mechanistic competition model of the host-parasite association taking into account all relevant factors can be a valuable tool in predicting the effects of alternative sowing strategies.

In this study, the Faba Bean module and the newly developed Parasite Module of the Agricultural Systems Simulator (APSIM), a cropping systems model, were parameterised and evaluated using data from field trials conducted in the Cukurova region of Southern Turkey. The investigated experimental factors included sowing date, parasite seed density and faba bean cultivar. The evaluated model was then employed to carry out simulations using historic weather data to simulate expected faba bean seed yields as influenced by a range of sowing windows and different levels of parasite infestation under the conditions of a mediterranean-continental (Tel Hadya, Syria) and a coastal mediterranean (Adana, Turkey) environment. Our results illustrate how optimum sowing dates as well as attainable yields depend on both parasite seedbank and site conditions.

Keywords: Orobanche simulation, APSIM, weed management

Rainfall Variability Studies in South Sulawesi Using Regional Climate Model REMO

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The regional climate model REMO has been applied to study rainfall variability in South Sulawesi, Indonesia by comparing model data with observations. During the period 1979–1993 data correlation was 0.82. A high correlation (more than 0.90) was obtained during El Niño year 1987. At the La Niña year 1988/1989, the results of REMO simulation under estimates the observation data. The pattern of rainfall variability related to ENSO phenomena was similar to observations. Rainfall at El Niño year is lower than average while at La Niña year rainfall is higher than average. The lower rainfall as an impact of El Niño and the higher rainfall as an impact of La Niña occur simulated and measured during dry season, whereas the rainfall during the wet season is not altered significantly. Rainfall amount can, therefore, be looked upon as a successful indicator of the model.

The model domain for this study includes Sulawesi (Celebes island), the east part of Kalimantan (Borneo island) and Maluku island. The borders of the model domain at the left corner is 117° E; 7° S and at the right corner is 129° E; 3° N. Input data used for running REMO 1/6° come from the output of the same model at 1/2° resolution. In turn, REMO 1/2° uses input data from ECMWF Re Analyses or ERA15 data (15 years period from 1979–1993). According to the period of ERA15 data, the rainfall simulation in South Sulawesi are conducted for this period. For this validation purpose, the rainfall data are obtained from meteorological, climatological and geophysical stations network belonging to the Indonesian Bureau of Meteorology and Geophysics (BMG). Other data were obtained from rain gauge and climate stations operated by several institutions (Agriculture Department, irrigation section of Department of Public Work) beyond these of BMG.

Keywords: El Niño, La Niña, Rainfall variability, rainfall simulation, Sulawesi

Approach for the Development of a GIS as a Tool for the Integrative Assessment of Natural Resources and Sustainable Rural Development in the Mata Atlântica, Brazil

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The paper will report on the application of a GIS to integrate data and information generated within a wider interdisciplinary research project. In that context it is used for the assessment of an endangered natural ecosystem with the aim to offer policy makers and planners a tool to investigate the environmental impacts of interferences in the natural systems, like de- or afforestation or different agricultural practices, on regional as well as on local scale. The design of the GIS is oriented towards a follow-up application by the environmental manager of forest protection areas as well as for the coordination of agricultural extension service on federal state level.

The specific challenge for applying GIS lies in the integration of data in various spheres and levels to provide information for a range of decision fields. The agricultural sector and the natural resources form the core of competing spheres. Research focuses on two valuable natural assets: (1) Forest fragments with specific characteristics, depending on location, size, stage of succession, and — as a major factor for biodiversity preservation — their connectivity by corridors; (2) the water resources of the watershed. The previously mentioned decision fields can be subdivided into different management tasks on different levels. First the environmental protection strategy on the regional level or even the state level (e.g. the state of Rio de Janeiro) has to be mentioned, second the decision of management practices on the local level, and third the monitoring of the status within the protected areas. The different levels of decision making already described require different working scales.

The strength of the GIS is the possibility of displaying and analysing the spatial characteristics of a system. Furthermore GIS is an excellent tool to store additional attribute data (e.g. ecological, meteorological as well as socioeconomic) connected to spatial subdivisions. Within the interdisciplinary research framework, data requirements for pre- and post-processing for modelling purposes can be specified and the problem of processing data from different data sources has to be solved.

Keywords: Atlantic rainforest, endangered natural ecosystem, fragmentation, GIS, interdisciplinary modelling, monitoring, natural preservation, rural sustainable development

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Scenarios of a Potential Landscape Development Regarding Factors of Forest Conversion and Soil Degradation in Eastern Bolivia

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The eastern Bolivian lowland is located in an ecological transition zone between the dry tropical Chaco forests, the Brazilian Cerrado-Savannah complex and the humid tropical rainforests of the Amazon basin. Due to the intersection of different bio-geographical zones, tropical deciduous forests with a high biological diversity emerged. Since the agrarian reform in 1953, these forests were gradually cleared for agriculture, principally cash-crop farms. The highest deforestation rates occurred in the 90's with clearing of wide plots for soy bean cultivation. According to the land-use plan of Santa Cruz a significant proportion of the deforestation area is part of a landscape not suitable for agriculture. The combination of the natural environmental conditions (climate, vegetation) as well as soil-types that are susceptible to degradation (compaction, loss of organic material) led to the classification as an ecological risk zone, which responds very sensitively to human impacts. This effect can be observed a few years after clearing and intensive agriculture in numerous abandoned fields or pastures. However, the economic basic conditions force the Bolivian government to maintain the pressure on the natural resources on a high level. As a consequence the region has been identified as one of the most endangered areas in the Neo-tropics.

Our study examines the potential landscape development in the main cultivation zone east of the city of Santa Cruz regarding factors of soil degradation and forest conversion. The main objective is the development of a system, which is capable to identify potential landscape changes in the future. The system development is based on the principles of the scenario formation and uses particularly fuzzy logic methods. Remote sensing data will be analysed in order to show the conversion of forest areas into agriculture since the 80's (change detection). The results are compiled together with soil, climatic and infrastructure data in a GIS data base. With respect to relevant parameters related to people - environment interactions (driving forces) practical decision rules will be deduced, tested and evaluated. The results are to be of service to national non-governmental organisations (FAN, FCBC) as decision support in regional land use planning.

Keywords: Bolivia, decision support, deforestation, GIS, land use planning, soil degradation

BenIMPACT — A Decision Support System for Agricultural Policy and Sustainable Use of Resources in Benin

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Rapidly changing climatic and socioeconomic conditions have major impacts on food security, rural poverty and resource availability in developing countries like Benin in West Africa. Decision support systems for agricultural policy can contribute to design strategies for the mitigation of critical developments.

In this context the poster presents BenIMPACT: Benin Integrated Modelling System for Policy Analysis, Climate and Technology Change. It consists of an Agricultural Sector Model, a tool to calculate water balances and impacts on crop yield (Crop Water Requirements-calculator) and a basic data system, linked to an Internet based interactive mapping tool (BenMap) for result exploitation.

The system is developed in the context of the IMPETUS-Project, which explores interdependencies between resource availability and socioeconomic developments in Benin. Results of various international research activities of natural and social sciences feed into the modelling system, which analyses scenarios regarding resource utilization and food security in Benin until 2020.

The Agricultural Sector Model covers the most important crops on a regional level, integrating aggregate primal-dual programming models maximizing agricultural profits with transport cost minimization and a globally well-behaved demand system. The Crop Water Requirements-calculator serves to calculate water balances per crop and region, defining constraints in the programming models as a result of temporal and spatial rainfall variation and evaluates impacts on yield.

Preliminary results indicate severe problems in the decade ahead, due to the combined impact of increasing population, limited availability of fertile soils, and regional and temporal water scarcity. BenIMPACT will provide concrete information on necessary changes in management systems and policy measures to prevent an impending economic and ecological crisis in Benin.

Keywords: Decision support system, Benin, rural poverty, food insecurity, resource scarcity

Application of Numerical Models to Estimate Rainfall Erosivity in Ethiopia — A Case Study of the Central Highlands

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Land degradation through water erosion poses a severe ecological threat in Ethiopia. The country's highlands lose 1.9 million tonnes of fertile soil per annum. Each year, the region's agricultural lands lose 100 tonnes of productive soil per hectare. Onsite effects of water erosion cause 2% reduction in Ethiopia's cereal production per annum, affecting the country's food supply significantly. Previous studies report only a rough estimate of soil loss from the central highlands. However, in spite of its key role in causing water erosion, the erosivity of rainfall is not sufficiently addressed. The aim of this co-operative research project is to assess rainfall erosivity in the study area, and to develop forecasting models applicable at local and regional scales. Long-term rainfall data (1898–1997) of 168 weather stations throughout the country were statistically analysed. The Modified Fournier Index — recommended for Ethiopia by the FAO — was applied to derive the index of water erosion potential. In addition, precipitation data of 44 selected weather stations in the agricultural region of the central highlands of Ethiopia were statistically analysed in further detail, using monthly rainfall data ranging from 30 to 100 years. This contribution presents selected results of this research project which enable to estimate and to forecast the risk of water erosion potential at local and regional levels. It was confirmed that rainfall erosivity in Ethiopia is very high, and it represents potential threat to the ecology and the economy of the country. As could be concluded from seasonal rainfall distribution, soil loss from the study area mainly occurs during summer. The stochastic numerical models developed in this study enable to estimate and prognoses water erosion potential at local and regional scales in the event of limited financial and physical resources as well as database. Rainfall and land management database should be enhanced to enable to test and validate resource management models, and to conduct their sensitivity and stability analyses. Soil erosion should be more efficiently controlled and further research carried out to find out more efficient control techniques suitable for the agro-ecological regions of the study area.

Keywords: Forecasting, land degradation, modelling, resource management, soil loss

Assessing the Impact of Agriculture on Water Quality — A Case Study from Central Chile

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Irrigated Agriculture has an impact on the quality of ground and surface waters. These impairments in turn can have negative effects on ecology and economic development. In order to quantify these impacts there is a need to develop adequate methodologies and modelling approaches. These approaches should be reliable and built on readily available data or data which can be measured cost-effectively.

In this paper a planned project in Central Chile taking the Aconcagua and La Ligua watersheds as an example is presented. The study is focusing on the impact of fertilizer application in irrigated agriculture on the quality of ground and surface waters. First the human and physical environment of the region are presented. In a second step the conceptual model is described and finally the related monitoring plan. One of the major challenges in the region is high spatial and temporal variability of the determining factors for water pollution like precipitation, discharge, soil types and fertilizer application. On the basis of test areas which are studied in detail the factors that have the biggest impact on water quality are singled out and are quantified. In a further step these factors are applied to a larger (watershed) scale in order to quantify the impact of agriculture on ground and surface waters. Various deterministic and stochastic approaches are applied.

The modelling is supported by a GIS and data are kept in a central database accessible via web by the project partners and other interested groups via the internet. This project is realized by an interdisciplinary team consisting of agronomists, hydrologists, chemists and economists of the catholic University of Valparaíso, Chile and the University of Applied Sciences Cologne, Germany.

Keywords: Irrigation practice, monitoring, non-point pollution, watershed management

The Need for Improvement of Crop-Soil Simulation Models for their Application in Conservation Agriculture

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Conservation agriculture (CA), a general term for a series of resource-conserving agricultural practices, has seen a tremendous worldwide spread in the last years. CA practices have been promoted for at least the last 20 years in Central and South America and in the USA, with remarkable success and benefits to the environment. One of the still “best-kept secrets” might be the adoption of CA in the Rice-Wheat systems in South Asia. Starting from a modest 3,000 ha of zero-till wheat in 1998–99, in the 2002–2003 season CA is being practised on roughly 500,000 ha in the Indo-Gangetic Plains. Three agronomic practices seem crucial for CA: avoidance of soil disturbance (reduced/zero tillage), residue retention and crop rotation. These three components must be locally adapted based on factors such as climatic and edaphic conditions, cropping systems, type of farmer and the socio-economic situation. To guide the transition from conventional agriculture to CA, detailed knowledge is required about how a given agricultural system will respond to CA practices. While understanding of basic processes underlying CA has advanced rapidly, there is still a pressing need to refine our ability to integrate effects of climate, soils and management in a predictive fashion. Systems research tools such as crop-soil simulation (CSS) models can increase the efficiency of the necessary research by quantifying the impact of different variables on productivity and resource conservation. However, CSS models were originally developed for conventional agriculture systems. Thus, the influence of reduced tillage and residue retention on soil physical parameters, such as infiltration rate, soil evaporation, water holding capacity and soil temperature, and their effects on surface runoff/erosion, crop soil water availability and crop emergence are seldom addressed. The poster describes how soil physical parameters would be expected to be affected in the short or medium term by CA practices. The current status quo of the capability of some most common CSS models to tackle these dynamics is highlighted and scope for improvement is given. To promote collaboration in modeling CA practices, CIMMYT and USDA-ARS have started an initiative to facilitate communication between researchers worldwide active in modeling CA systems.

Keywords: Conservation agriculture, crop model, modelling procedure, soil physics, zero-tillage

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Remote Sensing as a Tool for Investigating Vegetation Dynamics in West-Africa

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Within the last decades there is dramatic change in the land use/land cover (LUCC) in West-Africa recorded. Growth of population, climate change, exhausted soils and refugees from countries with civil war put pressure on the ecosystems. Decision makers need precise information about the LUCC and the underlying processes to set up management plans for an sustainable development. Within the IMPETUS project remote sensing was utilised for investigate the LUCC in two catchments north (Morocco) and south (Benin) of the Sahara. With Remote Sensing the needed information can be gained for great spatial units even for areas which are not easy accessible.

Vegetation dynamics within the semi humid tropics has different temporal scales. There are the inner seasonal vegetation dynamics due to the change of wet and dry season. On the other hand there is the long term change of land cover and land use caused by human impact or long term climate change. The assessment of actual vegetation cover in parts of Benin and Morocco was done by analysing recent LANDSAT 7 ETM+ scenes in a resolution of 30 m. Therefore an advanced knowledge based classification method was developed. Intensive ground truth campaigns backed the classification.

Inner seasonal vegetation dynamics were investigated with LANDSAT 7 ETM+ scenes showing different stages of the vegetation within an annual phenological cycle. Additionally SPOT VEGETATION satellite data provide every day information of the vegetation for whole Africa in a resolution of 1 km × 1 km. Merging the different data sources increases the knowledge of the vegetation dynamics in the areas of investigation. The long term changes of the land use / land cover were assessed with historic remote sensing data of different spatial resolution. Therewith it is possible to derive the pattern and the speed of the LUCC. Now this information is linked with socio-demographic data to understand the processes of the LUCC and to set up scenarios for further development. Based on that scenarios the decision makers can set up management plans for a further sustainable development.

Keywords: Benin, remote sensing, vegetation classification, West Africa

Evaluation of Two GIS-Based Models for Landslide Prediction

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Agriculture sustainability studies, commonly undertaken on farms in areas selected as representative, pinpoint the importance of hillside management and protection. However, a vulnerability analysis with regard to landslide risk is commonly nonexistent. An alternative to costly long-term geotechnical studies may lie in simple and fast tools (models) for a contemporary analysis of regions of interest. However, models are generally built upon average or common climatic conditions and do not account for rare and unpredictable variations, such as “Hurricane Mitch” 1998 in Central-America. The objective of this study was to assess the success of landslide prediction based on combination of readily available spatial data and two commonly available GIS-based models, under the conditions of this extreme meteorological event.

The chosen models represent the outer edges of methods used in (landslide) modelling: Deterministic or process-driven (SINMAP) and probabilistic (ArcWofE). The quality of the modelling results was assessed by comparing known areas of risk (all known landslides in the study region mapped by GPS) with predicted areas of risk. An additional criterion was the utility value of the results. SINMAP can differentiate between areas with lower and higher risks, but only with insufficient accuracy. This allows the conclusion that either important landslide driving processes are neglected, or the underlying assumptions of process behavior are too general. SINMAP must be considered an insufficient tool for landslide prediction under severe meteorological events.

ArcWofE accurately distinguished areas with high landslide densities, however it could not account for the vast majority of landslides. Besides limiting the applicability, this opens the further question whether what is currently known about landslides is sufficient enough to explain landslides occurring under severe meteorological events. A perspective for the future are models combining the two methods. These are currently being developed and can be expected commonly available in future.

Keywords: GIS, landslides, modelling

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Impact Assessment

DOUGLAS HORTON, RONALD MACKAY:

**Using Evaluation to Enhance Institutional Learning and Change —
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Using Evaluation to Enhance Institutional Learning and Change — Recent Experiences with Agricultural Research and Development

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National agricultural research organizations as well as centers affiliated with the Consultative Group on International Agricultural Research (CGIAR) are under strong pressure to enhance their contributions to poverty alleviation, food security and protection of the environment and to demonstrate the results of their work. The dynamic world environment demands continuous changes in the ways in which research organizations operate and relate to other actors in agricultural innovation systems. To date, agricultural research evaluation has been dominated by economic impact assessment frameworks and methods. Designed as research studies, impact assessments have often served accountability and public awareness purposes. However, they have been of less use to further the understanding of how policies, programs and technologies may or may not contribute to agricultural innovation. There is an increasing awareness that appropriately designed and executed evaluations — going beyond traditional economic impact assessment — can contribute substantially to institutional learning and performance improvement. This paper outlines some of the limitations of traditional economic impact assessment and outlines some innovative approaches to evaluation that contribute more directly to learning and institutional change.

Keywords: Agricultural research, evaluation, impact assessment, organizational learning

Establishing Plausibility in Impact Assessment

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Evaluators often try to quantify and prove the impact of agricultural research at a highly aggregated level such as farmers' welfare, household food security or the nutritional status of children. In many cases, however, attribution gaps that are caused by the existence of too many other significant factors make it impossible to isolate the effects of a single development intervention such as research.

Based on the critical review of an IITA impact study of soybean, this paper demonstrates the importance of establishing plausibility when inferring from the results of agricultural research to changes in the well-being of farm families and rural communities. It is argued that, to require impact assessment studies to establish more than plausible relationships between research results and developmental impact would force evaluators to gloss over much information and over-interpret the available data.

A reasonable compromise would be to trace out impact pathways and to establish plausible links between research investments and observed development impact(s). Seven standards are suggested as elements of good practice in impact assessment and evaluation feedback that should be included in impact studies: (1) A description of the agricultural research investment and its context; (2) The model or concept of innovation; (3) The objectives, scope and limitations of the evaluation; (4) The logic model underlying the project or programme; (5) The statement and testing of a concrete impact hypothesis; (6) A discussion of other factors that could have affected the observed changes; and, (7) A critical review and comment of the findings.

Applying these standards in impact assessment of agricultural research for development should help to strengthen the plausibility of impact claims at a justifiable cost.

Keywords: Agricultural research, impact assessment, innovative evaluation approach, plausibility

Assessing Nutritional Impact of Agricultural Research

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Evaluation of agricultural research often neglects consumption and nutrition aspects. This paper briefly reviews the conceptual linkages between the two sectors agriculture and nutrition. It presents methodologies for assessing the nutritional impact of commodities, and it summarizes current impact evidence on the pathway from commodity research to consumption. The paper concludes by highlighting future research needs.

Keywords: Agricultural research, evaluation, impact assessment, nutrition

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European Commission Funding for Co-ordination of Research Activities in the 6th Framework Programme

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In the past, collaborative actions have been initiated at European and Community level. It is time to bring these endeavours together and to build a research and innovation equivalent of the “common market” for goods and services. That structure is called the European Research Area and is regrouping all Community supports for the better co-ordination of research activities and the convergence of research and innovation policies, at national and EU levels.

The 6th Research Framework Programme is the most important element of this new strategy. Following the principle of subsidiarity, projects have to be transnational: consortia of partners from different member states and accession countries, including optional partners from associated countries or INCO target countries can apply. For mobility and training actions the fellows have to go to a country different from their country of origin or residence. Activities that can better be carried out at national or regional level, i.e. without co-operation across borders will in general not be eligible under the Framework Programme.

A set of new instruments has been introduced:

Support for the **networking of centres of excellence** in different countries — and situated equally in universities, research centres and organisations and in business enterprises. These networks will have clearly defined thematic objectives and will be directed towards advancing scientific and technological knowledge, within medium- to long-term time-frames; support for **integrated projects**, involving a critical mass of scientific and industrial partners, and directed toward significant products, processes or service applications;

Focus and concentration is another feature of FP 6

FP6 does not cover all areas of science and technology (with the exception of some special actions, like the ERA-net scheme — see below). A limited number of thematic priorities have been identified. Detailed descriptions of these areas and specific topics will be given in the calls for proposals. Potential participants have to check carefully if their ideas for projects fit within the scope of these priorities and topics.

For agricultural research for development

- The INCO programme is the prime activity to check (<http://www.cordis.lu.fp6/inco.htm>). The first call closed on 11 September 2003, further calls are planned to be published in March 2004 and 2005 with closure dates in September.

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- Thematic priority 5: Food quality and safety (<http://www.cordis.lu.fp6/food.htm>). Further indicative deadlines: Feb. 2004, Sept. 2004, January 2005, Dec. 2005 and
- Thematic priority 6: Sustainable Development (<http://www.cordis.lu.fp6/sustdev.htm>): Currently a call is open, with various deadlines depending on the instrument and area
- Marie Curie actions — Human resources and mobility (<http://www.cordis.lu.fp6/mobility.htm>)

A specific new feature in FP 6 is the ERA net scheme:

The objective of the ERA-NET scheme is to step up the co-operation and co-ordination of research activities carried out at national or regional level in the Member States and Associated States through: the networking of research activities conducted at national or regional level, and the mutual opening of national and regional research programmes.

The scheme will contribute to making a reality of the European Research Area by improving the coherence and co-ordination across Europe of such research programmes. The scheme will also enable national systems to take on tasks collectively that they would not have been able to tackle independently.

Both networking and mutual opening require a progressive approach. The ERA-NET scheme therefore has a long-term perspective that must also allow for the different way that research is organised in different Member States and Associated States.

More information is available at: <http://www.cordis.lu/coordination/era-net.htm>

A call was published on 17 December 2002, with cut-off dates on: 03 June 2003, 02 March 2004, 05 October 2004, 02 March 2005 and 04 October 2005.

Keywords: European Commission, integrated projects, The 6th Research Framework Programme

Research on Tools for Sustainable, Far-Sighted Management of Natural Resources

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It is not unusual when living conditions are changing, but there is some evidence that for future generations especially in less developed countries the susceptibility to natural and man-made changes in the earth habitat will increase. Important factors are the growth of population and the increasing use of natural resources inevitably associated with it, the globalization of economic systems and global environmental changes which are, at least partly, caused by this development. By signing several international conventions (e.g. CSD, CBD or FCC) Germany agreed to support efforts aiming at the development of measures towards more sustainability.

Research is playing an important role in this context, because strategies towards more sustainability should rely on comprehensive knowledge of the functioning and dynamics of both, natural systems and systems of civilizations. However, the complexity of the processes involved means a great challenge to science, as interactions go beyond the traditional borders of disciplines, sectors and also environmental media. More inter- and transdisciplinarity is needed. This new general research strategy is embedded in a broad international Global Change Research Network.

BMBF is now setting a special focus on projects aiming at the development of tools for sustainable, far-sighted management of natural resources, like for example water and biodiversity. The bi- and multilateral projects are selected via thematically focused open calls. In the independent review process not only scientific quality and feasibility of the proposals, but also the involvement of researchers and stakeholders of the host countries are assessed. Capacity building is becoming a crucial issue for this kind of research.

Examples for currently running BMBF funding activities:

- GLOWA (Impacts of Change in the Global Hydrological Cycle) www.glowa.org
- BIOLOG (Biodiversity and Global Change) www.biolog-online.info, esp. www.biota-africa.org

Sustainable Land Use and Rural Development in Mountainous Regions of Southeast Asia

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Rapid population growth reinforced by policy-induced migration (resettlement policies, demarcation of conservation areas, construction of dams) has increased the pressure on land in the mountainous regions of Southeast Asia to an extent that degradation processes take on self-escalating dynamics with declining soil fertility and agricultural productivity pushing people into more poverty, and poverty leading to reduced fallow periods and degradation of natural resources. The Uplands Program (Sonderforschungsbereich 564) wants to contribute to a better management of natural resources and to an improvement of rural livelihoods in these mountainous regions of northern Thailand and northern Vietnam. Through the Program's participatory approach the priorities of the stakeholders involved in the management of natural resources and in rural development processes will be integrated. Participation, sustainability and interdisciplinarity are central components of the Research Program.

The Program focuses on two main research fields mutually interlinked: sustainable land use and sustainable rural development. The basic hypothesis is that sustainable land use can only be achieved if off-farm employment is created and an appropriate institutional framework is designed.

Research on sustainable land use concentrates on the stabilization of land use systems in mountainous regions requiring a system approach encompassing an entire watershed area. The research field comprises three project areas: soil, water and energy conservation, bio-diversity in agro-eco systems, plant and animal resources and sustainable and integrated production systems. Research on sustainable rural development focuses on analysing opportunities to better integrate sustainable land use systems into the regional development process. By elaborating appropriate technologies for the local industrial processing of agricultural products as well as by designing suitable institutions and policy measures, the evolvement of sustainable land use systems and agricultural practices will be supported. Processing and marketing of agricultural products and rural institutions and policies are the main research fields.

The Program is set up to cooperate with the Chiang Mai University and the Kasetsart University in Thailand, complemented by Maejo University and Silpakorn University. In Vietnam the Program cooperates with the Hanoi Agricultural University, the Thai Nguyen University of Agriculture and Forestry and the two science institutes: Vietnam Agricultural Science Institute and the National Institute of Animal Husbandry. In addition, the Program cooperates with many bi-lateral and international research programs in both countries.

Keywords: Rural development, sustainable land use system, Southeast Asia, SFB

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Stability of Rainforest Margins

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The Sonderforschungsbereich (SFB 552) of the DFG (Deutsche Forschungsgemeinschaft) is a long-term Indonesian-German research program that began in July 2000. A key feature of the SFB entitled Stability of Rain Forest Margins (STORMA) is its interdisciplinary approach in analysing land use systems in tropical rain forest margins and their impact on socio-economic and agro-ecological systems. Researchers from two German universities (Göttingen and Kassel) and two Indonesian universities (Agricultural University Bogor, and University Tadulako) participate in STORMA, representing diverse disciplines such as plant and landscape ecology, agricultural and resource economics, rural sociology, cultural geography, and bioclimatology.

The research task of STORMA is to analyse and assess the factors and processes of land use that stabilize or destabilize tropical rainforest margins both in their temporal and spatial dimensions. The research area is the Lore Lindu National Park and its surroundings near Palu, Central Sulawesi, Indonesia. The **principal research objectives** of SFB 552 are:

- the analysis of key factors and processes that lead to destabilisation and forest degradation in the forest margin zone;
- the identification and assessment of social, economic, political and ecological conditions that are imperative for the stability in the forest margin zone; and
- the development of rapid appraisal systems and integrated interdisciplinary models that aim to evaluate the socio-economic and ecological consequences of existing and alternative rural development and nature conservation policies.

The research program features a joint Indonesian-German project steering and management that explicitly aims at promoting graduate and post-graduate education of young scientists, mainly from Indonesia and Germany. During the second phase (July 2003 to July 2006), the thirteen individual research projects of STORMA contribute to three focal points of investigation:

- Focus 1: Integrated modelling of land use in the rain forest margin zone: Alternative land use strategies
- Focus 2: Sustainable management of agroforestry systems
- Focus 3: Ecological and socio-economic impacts of different forest use intensities

With regard to focus 2 and 3, researchers from the socio-economic and natural sciences work in the same villages, households and plots to facilitate exchange of data,

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and thereby contribute to focus 1 which seeks to integrate the different data and sub-system models through a land use model. A key feature of STORMA is therefore the **collaboration** of the **socio-economic sciences** on the one hand and the **natural sciences** on the other: It aims at bridging a traditionally wide gap in the definition, understanding and solution of problems related to man-nature interaction. These interdisciplinary initiatives have focussed on selected themes that are particularly relevant with regard to the stability of rainforest margins. They include, for example, **(1)** the impact of deforestation on the water availability and water quality of rural households, **(2)** the impact of hunting and deforestation on endangered wildlife species and its implications for conservation, and **(3)** the spread of cacao diseases, which constitute a major problem in the research area.

Apart from the DFG as the main funder, STORMA is supported by the BMZ, the BMBF, the state of Hesse and Lower Saxony, the four partner universities, the DAAD, the Indonesian Ministry of Agriculture and Forestry as well as the Directorate General of Higher Education.

Keywords: Agroforestry system, forest degradation, land use modelling, SFB

The Concept of the DFG Joint Research Projects with Special Regard to Collaborative Research Centres

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The DFG is the largest provider of research funds to universities and the most important funding organisation of basic research. All programmes support and encourage international cooperation. Besides the Individual Grants Programmes there are several joint research programmes which can be conducted by German scientists in cooperation with researchers or research institutions in developing countries.

Collaborative Research Centres are long-term university research centres in which scientists and academics pursue ambitious joint interdisciplinary research undertakings. This funding instrument aims to create core research areas at universities. The programme is focused on strengthening the research capacity and the scientific efficiency of the participating scientists in the respective developing countries in order to help to solve specific problems. Collaborative Research Centres are funded for a maximum of 12 years. Every four years the DFG reviews the research programmes and budget of each individual centre and evaluates the results achieved in the preceding funding period. This evaluation is the basis for the annual funding decisions of the Grant Committee for Collaborative Research Centres. In 2002 312 Collaborative Research Centres were funded with a budget of EUR 361.9 million. Eight centres dealt with topics that are relevant to developing countries, especially Africa. Examples of areas to be studied were the consequences of cultural developments and changes as well as the history of languages and settlements. The goal of a biomedical Collaborative Research Centre is to control tropical diseases. Two other centres dealing with land use concepts in developing countries will be presented at the meeting in detail.

Another example for joint research projects in which partners from developing countries can be involved are Research Units. They support close partnerships in high-quality research ventures at one or more locations and are funded up to six years. They often contribute to establishing new research directions. In the frame of Priority Programmes the participating researchers from all German research institutions are free to choose their topics, research plan and methods in a supraregional cooperation. Research Training Groups are combined research and study programmes established at German universities for a period of time for the purpose of promoting young researchers at one location. They afford doctoral students the opportunity to complete their doctorates within a coordinated research programme. Some examples will be presented.

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The DFG generally provides the funds necessary for the German share of the project while the BMZ covers costs which the cooperating partner in the developing country incurs in connection with the implementation of his share. Specifically, BMZ may provide financial support for the purchase of scientific materials e.g. consumables and scientific equipment, but also for local casual labour, and for journeys the co-worker may need to undertake in his/her own country or to Germany. It is not possible to finance the whole infrastructure of the foreign universities or other research institutions. In general, an adequate financial contribution of both parties is expected. The qualification of the applicants and the scientific relevance of the proposal are the main prerequisites for funding, despite of the relevance of the planned project for the developing country involved.

Keywords: DFG, Research support, Collaborative Research Centers, SFB

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