

# Deutscher Tropentag 2004

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

## **Rural Poverty Reduction through Research for Development and Transformation**

### Book of Abstracts

#### **Editors:**

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R. Schultze-Kraft, L. Bharati, C. Bonte-Friedheim,  
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Humboldt-Universität zu Berlin

October 5-7, 2004



# Impressum

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

Rural Poverty Reduction through Research for Development and Transformation: international research on food security, natural resource management and rural development ; book of abstracts / Deutscher Tropentag 2004 Berlin.

Hrsg.: Kurt J. Peters, Dieter Kirschke, Winfried Manig, Andreas Bürkert, Rainer Schultze-Kraft, Luna Bharati, Christian Bonte-Friedheim, Andreas Deininger, Netra Bhandari, Henrik Weitkamp. —

Köthen : druckhaus köthen GmbH, 2004

**ISBN:** 3-86004-182-7

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## **Editors:**

Kurt J. Peters, Dieter Kirschke, Winfried Manig, Andreas Bürkert, Rainer Schultze-Kraft, Luna Bharati, Christian Bonte-Friedheim, Andreas Deininger, Netra Bhandari, Henrik Weitkamp

## **Issued by:**

druckhaus köthen GmbH, <http://www.koethen.de>

## **Online-Versions:**

Print-Version, pdf: <http://www.proceedings2004.tropentag.de>

Web-Version, HTML: <http://www.abstracts2004.tropentag.de>

## **Layout:**

Andreas Deininger, Netra Bhandari

## **Typesetting:**

L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub>

## **Printed by:**

druckhaus köthen GmbH

Friedrichstraße 11/12

06366 Köthen

## **September 2004**

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# Preface

The **Deutscher Tropentag (DTT)**, the International Conference on Research for Development in Agriculture and Forestry, Food and Natural Resource Management is an annual event alternately organised by five German Universities in co-operation with the Association for Tropical and Subtropical Agricultural Research (ATSAF), the GTZ Advisory Service on Agricultural Research for Development (BEAF) and the German Forum on Research for Development (DFOR).

The Deutscher Tropentag 2004 is the sixth annual meeting providing a forum for all scientists, experts and students involved in research for development. The DTT 2004 conference theme is *Rural Poverty Reduction through Research for Development and Transformation* with six sessions in five different thematic areas covering research results from a multi-disciplinary perspective. The organisers are overwhelmed by the large number of submitted contributions from scientists in Europe, Africa, Asia and Latin America, indicating that the Deutscher Tropentag (DTT) is recognised as an international event on the agenda of the development oriented scientific community and decision makers. The program and proceedings are published on [www.tropentag.de](http://www.tropentag.de).

The organisers kindly acknowledge the support obtained from the Federal Ministry for Development and Technical Cooperation, the Vater and Sohn Eiselen-Stiftung, and the Agricultural and Horticultural Faculty of the Humboldt-Universität zu Berlin.

Berlin, October 2004

For the Organising and Scientific Committee DTT 2004

Prof. Dr. Kurt J. Peters

Humboldt-Universität zu Berlin

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# Plenary Speech

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ULRICH MOHR:

**Experiences of Implementing Poverty Reduction Programmes and  
Policies**

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## Experiences of Implementing Poverty Reduction Programmes and Policies

ULRICH MOHR

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

The challenges of combatting rural poverty in developing countries are well-known. In the last few years, the international discussion focused on the lack of attention among donors and national decision makers to address rural poverty in an appropriate way. Two recent studies commissioned by GTZ have revealed that agriculture still plays the most important role for increasing rural incomes and livelihoods. However, support should focus more on value-added activities and the institutional dimension instead of increasing production of bulk commodities alone.

GTZ advocates approaches that address the major technological, institutional and policy constraints for rural poverty reduction. Frequently, these have to tackle simultaneously, especially in the least developed countries. Therefore, GTZ, on behalf of the Ministry of Economic Cooperation and Development (BMZ), embarked on programme-based approaches that combine interventions at different levels, often in cooperation with KfW, DED and international donors. Support to the agricultural sector forms part of these programmes although they may have a different focus, e.g. rural development, natural resource management or general economic development.

At the policy level, support for trade policy development figures prominently among the priorities of our partner countries. Similarly, policy advice is needed to integrate support to agriculture and non-farm rural economic activities into national poverty reduction strategies that carry often an urban bias. In terms of the institutional factors, current priority areas are land reform, improving farmer's access to markets and services, and integration of small-scale producers into value chains. We use public-private partnerships as a new mechanism to ensure a demand-led focus and to improve prospects of upscaling best practices.

Support to technology development plays a less prominent role than several decades ago. However, new challenges have emerged that need to be addressed, e.g. food safety standards and renewable resources. Also, we are constantly striving to target the support to international and national agricultural research systems toward achieving higher development impact, especially with regard to rural poverty, gender equality and environmental sustainability.

**Keywords:** Institutional factors, policy, programme-based approaches, value-added activities

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# Session 1: Institutional and Policy Challenges

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## **Lack of Institutional Arrangement — The Root of Poverty in Agricultural Sector**

AHMAD ERANI YUSTIKA, WINFRIED MANIG

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In recent years economists have given increasing attention to the set of ideas that has come to be known as New Institutional Economics (NIE). The NIE attempts to build a theory of non-market institutions on neo-classical foundations. It is important to note that the NIE operates at two levels —macro and micro. The macro level deals with the institutional environment, or the rules of the game, which affect the behaviour and performance of economic actors and in which organisational forms and transactions are embedded. The micro level analysis, on the other hand, also known as the institutional arrangement, deals with the institutions of governance. An institutional arrangement is an arrangement between economic units that governs the ways in which these units can cooperate or compete (TIAN, 2001:387; KHERALLAH and KIRSTEN, 2001:4; GRONEWEGEN, *et.al*, 1995:5).

Based on the perspective, especially micro level of NIE, this empirical study in Indonesian sugar industry argues that poverty can be seen as an institutional arrangement problem. First, it is proven that there is such thing as unequal bargaining power among economic actors (for example the relationship between sugar cane farmer and sugar mill). Second, an asymmetrical information and interaction between principal and agent in establishing a working contract agreement (in the case of sugar cane farmers and cooperative / middleman / sugar mill). The two issues mentioned earlier are institutional arrangement phenomenon, which often occurred in agricultural sector. These issues have positioned economic actors to be in two polar categories: the winner and the loser. In the extreme case, the winner takes all and leaves nothing for loser (zero sum game). This condition has raised the issue of poverty— not only the economic disparity— to the surface.

**Keywords:** Indonesia, institutional arrangement, new institutional economics, poverty, transaction costs

## Can Agricultural Research Impact on the Poor? — Evidence from Dry Marginal Areas in Syria and Yemen

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Both public and private agricultural investment have always favoured the more productive areas where the potential for increasing yields and returns to investment are higher. The less favourable areas, where inherent agroecological conditions, low and erratic rainfall, eroded soils, steep slopes, small holdings and poor infrastructure prevail, are given low priority. This resource allocation is mainly justified on the basis of economic efficiency. The indirect positive impacts, in terms of off-farm employment and lower food prices, of the investments in more favourable environments on the poor are obvious. However, the environmental costs associated with the poverty-land-degradation relationship, the social costs of the high rate of migration to cities with burgeoning urban slums, the persistent rural poverty, and recent evidence suggesting comparable returns to investment in less favourable areas and larger impact on poverty than in the more favourable areas, raise fresh questions on the rational for continued low levels of investment in the dry areas.

Based on the results obtained from participatory research methods and quantitative analysis, the paper first describes and compares the livelihoods of rural communities in two marginal environments in Syria and Yemen, and identifies typologies of farming households based on their livelihood strategies and assets. The paper then examines the importance of agriculture in the rural livelihoods and the potential for production technology to increase farm income in these dry land environments. The paper identifies pervasive policies that negatively affect the rural poor in the case of Syria and critical gaps between policies targeting the rural poor and their implementation at the community level in the case of Yemen. There is, in both cases, complete absence of services such as credit, extension, veterinary and weak market access. We argue that lack of investment in rural institutions, services and infrastructure limits the potential impact of production technology and its relevance as poverty alleviation strategy. The study highlights the need for greater attention to policy, marketing, and rural livelihoods research in order to identify critical rural development opportunities for poverty alleviation in these dry areas.

**Keywords:** Agriculture, dry areas, livelihood, poverty, Syria, Yemen

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## **Integrating Research Results into Decision Making about Natural Resource Management at the Forest-agriculture Interface — A Case Study in the Congo Basin**

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Unlike Southeast Asia and the Amazon regions, where large-scale agricultural operations play an important role, most of the deforestation in the Congo basin is attributed to smallholder agriculturalists using extensive slash-and-burn techniques. Improved rural livelihoods are the key to poverty reduction and sustainability of landscape mosaics at the forest-agriculture interface of the Congo basin region. The issue has become more complex with globalisation and the situation therefore calls for an innovative approach that would look at trade offs between sustainability and productivity growth.

On this basis, a collaborative partnership uniting research institutes, non-governmental organisations and universities members of the Alternatives to Slash-and-Burn national Consortium in Cameroon work with local communities to identify and develop policy, institutional and technological land-use options that can improve rural livelihoods while preserving the country's remaining forests. During the first three Phases of the programme (1994 to 2003), the global objective has been to: characterise and evaluate existing land use systems; modify or develop alternative technologies to the practice of slash-and-burn cropping system; identify, assess and design policy tools and mechanisms through which they could be implemented with the aim of protecting the environment by reducing the rate of deforestation. So far, the Project main outputs include: baseline environmental, agronomic, economic, and social datasets compiled and assessed in six landscape mosaics of the Forest Margin Benchmark; different resource management options for increased productivity of annual crop-based systems, perennial crop-based systems, and community-managed natural resource systems tested with farmers in the benchmark area; integrative landscape-level models and participatory community action methodologies developed; local capacity built in the use and interpretation of the models and methodologies and their outputs/outcomes; and mechanisms for policy formulation and dialogue improved at the local, provincial and national levels, targeting landscape mosaic and natural resources management.

From the ASB experience, it is concluded that there is no single 'best bet' solution to rural poverty alleviation at the forest-agriculture interface of Congo basin region. Only by integrating technology development, policies and institutional innovation can the question "Are sustainable landscape mosaics feasible at the forest-agriculture interface in the Congo Basin region?" be addressed objectively.

**Keywords:** Alternatives to slash and burn, Congo basin, forest-agriculture interface, sustainable landscape mosaics

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## **Are Bioprospecting Benefit-Sharing Schemes an Option for Rural Poverty Reduction? — An Enquiry about the Kani Community of Tropical India**

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The creation of markets in environmental goods and services is attracting increasing interest in the policy arena. The creation of markets for bioprospecting is often advocated as means for counteracting the erosion of biodiversity as well as heralding indigenous knowledge (IK) by providing economic incentives to the indigenous communities. This paper presents a benefit-sharing study from a bioprospecting experience in which an indigenous community has obtained monetary compensation for sharing their IK on the medicinal plant *Trichopus zeylanicus*. The data used in the analysis was collected in 2004, in order to examine the impacts of a bioprospecting benefit-sharing scheme on the living standards of the Indian Kani tribes. The Kani is primarily a semi-nomadic community, who now leads a settled life in the forests of the Western Ghats, in tropical India. While the Kani community is rich with respect to its ethnobotanical knowledge, income poverty is prevalent with an average annual per capita income of US\$ 152. Furthermore, whereas the benefit sharing scheme was originally expected to provide the Kani settlements with improved public goods, the institutional impediments have resulted in a partial implementation of the plan. Furthermore, the analysis reveals that around an annual US\$ 1 million has been forgone in benefits to the communities from imparting their IK. In this regard, opinion documentation was obtained from Kani households about their IK and attitudes towards the existing benefit-sharing agreement and other potential bioprospecting contracts. This case study provides some policy recommendations with respect to the involvement of indigenous communities in drug discovery processes in order to help create more adequate bioprospecting endeavours in developing economies.

**Keywords:** Benefit-sharing, bioprospecting, Kani Model, Rural poverty reduction, Tropical India



## **The Subtle Distinction Between the Different Mayan Groups — Gender Gaps in Non-Agricultural Employment under the Focus of Interethnic Differences in Rural Guatemala**

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The literature has revealed that among the many positive functions of non-agricultural employment, there can be named the smoothing of income variations, income increases, an improved capacity to cope with risk and income shocks as well as the financing of investments in different types of assets. Especially for women the non-agricultural sector provides important employment opportunities. But for the first time in Guatemala, this analysis based on farm household theory takes interethnic differences within the gender aspects of employment into account. Using the data of the national ENEI survey of 2002, the descriptive and econometric results reveal significant interethnic and gender differences in the rural labour markets which have shown to play a central role in the following assessment of the diverse functions of non-agricultural employment. Nearly 70 % of the rural women primarily work outside agriculture. In fact, the probit model showed the sex of a person to be the strongest single determinant of non-agricultural employment. Women's participation in non-agricultural activities ranged from 22 % to 62 % according to the different ethnic groups. The observed interethnic differences raised the question on a possible cultural influence of non-agricultural activities of certain ethnic groups. In order to assess the specific functions of non-agricultural work at the household level, several case studies have been conducted among the Q'eqchi' and K'iche' population of Alta Verapaz and Totonicapán. The results indicate that the rather handicraft-based, low-productivity activities of the investigated Q'eqchi' households fulfil important functions concerning the reduction of diverse risks (related to harvest failures and price fluctuations of export products), the employment generation for women and the equalising effects on the intra-household distribution of income. In contrast, for the investigated K'iche' households the poverty-reducing effect is given by the substantial alternative income generation rather than by secondary effects related to the intra-household distribution or risk reduction. Finally, possible ethnic-cultural influence on the economic activities at the household level is discussed on the background of possible external factors including infrastructure and the structure of labour markets which might cause the necessity of income diversification. They seem to be important additional determinants of interethnic employment differences.

**Keywords:** Guatemala, interethnic differences, non-agricultural employment

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## **Innovative Policy Options for Poverty Alleviation — A Case of Leasehold Forestry of Nepal**

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In Nepal, forest is a very important resource for the livelihood of poor people. Since 1991, Community Based Leasehold Forest Policy (CBLFP) is formulated and implemented aiming to alleviate poverty of the rural poor and to rehabilitate degraded forest land. Degraded land is transferred to the poorest people to plant forest crops as well as forage to support livestock production. The user rights to the forest are provided over a period of 40 years. In addition to the cultivation of forest and forage crops, provision for credit, training for entrepreneurship development and institutional supports are linked to the programme. It is expected that this type of integrated and decentralised CBLFP should have an increased impact on poverty alleviation compared to conventional community forestry programmes. The main research question of the study was whether such an innovative policy intervention is able to address the poverty through allocating exclusive use right of the resource to the poor people.

In this case study, eight leasehold groups of Kavre district of Nepal were surveyed, addressing the poverty situation of the target group. Different tools of participatory rural appraisal (PRA) were implied to collect and triangulate the data. The main findings of the study are that after the implementation of CBLFP, poor people are in contrast to its objective excluded and further marginalised and occurrence of severe conflicts over the resource tenure were noted. As a policy recommendation, community based leasehold forestry programme should be integrated into existing community forestry programme with the inclusion of poverty alleviation component. Further, there should be the provision made to transfer user rights for well stocked forest to address poverty issues adequately to create incentive to the resource poor people to develop the degraded forestland.

**Keywords:** Leasehold forestry, Nepal, poverty alleviation

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## **The Role of Agricultural Policy in Soil Fertility Management Technology Choice among Smallholder Farmers in Malawi — Simulation with a Farm Household Bio-economic Model**

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Degradation of land, particularly the soil's productive capacity, poses a serious threat to current and future livelihoods of the mostly agrarian societies. The problem of excessive deterioration of soil productivity is often attributed to physical causes such as continuous cultivation, overgrazing, population pressure and climatic factors. However, more recent research based on multi-disciplinary conceptual frameworks, such as bio-economic modelling, has demonstrated that land degradation is largely a physical manifestation of underlying market failures that often distort farmers' incentive structure.

The main objective of this research is to explore the impact of agricultural policies on soil fertility degradation and sustainable agricultural growth in Malawi. The key policy research questions are to identify soil management options that result in the highest marginal returns in terms of yield responses, principally of maize (the staple food crop) and tobacco (the major cash crop); the relative benefits of these options in terms of ensuring sustainable soil productivity which is important for the country's agricultural growth; and the policy incentives that can facilitate farmers' uptake of such options. The research makes use of a dynamic optimisation framework that permits an integration of biophysical, socio-economic and policy factors. The relevance of such research in Malawi, is that like most Sub-Saharan African countries, it has become increasingly apparent that as a result of disincentives created by the economic environment, more and more farmers are compelled into unsustainable farming practices.

Simulation results highlight key agricultural policy issues that influence farmers' investment in soil fertility management options. Policy implications in terms of ameliorative options and their short and medium term productivity outcomes are also highlighted.

**Keywords:** Agricultural policy, bio-economic modelling, land degradation

## **Effects of Migration on the Source Communities in the Volta Basin of Ghana — Potential Links of Migration, Remittances, Farm and Non-farm Self-employment Activities**

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Using survey data from the Volta basin of Ghana, this article examines the effects of rural out-migration in the source community. Explicitly, it investigates the direct and indirect effects of migration from the rural areas on the income sources of the households that send out-migrants and it measures the various and sometimes competing effects of migration on the sending households and discuss policy implications. The study used the Zero Inflated Poisson (ZIP) model to get the predicted number of migrants in a household. Iterated Three Stages Least Squares (3 SLS) method followed by a bootstrapping procedure was employed to determine and measure the net effect of the migration in the income sources of households. The empirical study demonstrates that the loss of labour to migration has a negative effect on household farm income in source areas. However, we also provide evidence that remittances sent home fully compensate for this lost-labour effect, contributing to household incomes directly and also indirectly by stimulating farm and non-farm self-employed production. Consequently, this finding presents evidence in support of the New Economics of Labour Migration (NELM) hypothesis that remittances loosen constraints on production and the imperfect market environments characterising rural areas in developing countries. Hence, if government wants to decelerate the flow of migrants out of rural areas, they may need to interfere in credit markets by reforming the formal rural credit system to increase households' self-employed production efficiency and decrease the tendency to send migrants out into the labour force mainly to finance these activities.

**Keywords:** Migration, NELM, remittances, source community, Volta basin of Ghana

## Measuring Poverty in Northern Vietnam — An Assessment of Different Poverty Indicators

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During the 1990s, poverty reduction has become one of the major objectives of international and national development policies. For instance the United Nations' most prominent development target for 2015 is to halve the proportion of the world's people who live on less than a dollar a day. Many development aid projects and national programs are also aiming at the direct or indirect reduction of poverty. It is intrinsic to all this policies / programs / projects to measure poverty and to setup poverty lines to evaluate their performance. Many methods are available for measuring poverty. The most commonly used method is based on income or expenditure levels. However, in many cases it is far easier to measure expenditure than income and, moreover, it has a conceptual advantage. If incomes vary over time in fairly predictable ways, households try to keep their living standard despite income variability. Thus, there is still vast disagreement, which method is best to measure poverty. Besides, measuring poverty is a costly undertaking. Thus, effective and efficient ways to measure poverty are to be investigated. In Vietnam, measuring poverty by the Government is a well known activity. Each household in Vietnam is classified once per year according to its living standard into one of five classes. So far, these poverty measurements have had no practical use for evaluating non-governmental poverty reduction programs. Many non-government organisations (NGOs) are skeptical about the soundness of the official poverty data. However, if proved reliable, those data could save resources for many NGOs as costly poverty measurements would become obsolete. The aim of this paper is to give an overview of different options to measure poverty and to assess which method would be most applicable and reliable in Vietnam. Furthermore, a set of different poverty measures will be applied to a household database from Northern Vietnam and then compared to the Government data. This will allow drawing conclusions about its robustness. Methodological this contribution combines an in-depth literature review with a quantitative data analysis. The database consists of cross-sectional household-level data ( $n = 260$ ) from two districts in Northern Vietnam, collected in 2001/2002.

**Keywords:** Poverty, poverty indicators, poverty measurement, Vietnam

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## Assessing the Impact of Village Credit and Savings Associations on the Rural Poor in Low Rainfall Areas in Syria

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Worldwide, microfinance has been recognised as a powerful tool for alleviating poverty and raising living standards. In Syria microfinance is a very new industry and started only after 1997. The Rural Community Development Project (RCDP), of the UNDP and the Syrian Ministry of Agriculture and Agrarian Reform, established Village Credit and Savings Associations (sanadiq, plural of sanduq) in a dry marginal region southeast of Aleppo city. The sanadiq are considered as promising institutions to provide microcredits to poor small farmers and landless workers in the dry marginal areas of Syria. Their institutional setup enables them to operate where other formal lending institutions do not because of inappropriate land tenure systems or because it is considered risky due to irregular land productivity resulting from low and variable rainfall.

The study is based on a formal survey conducted in the area of the RCDP. This area includes 156 villages and about 27,000 households. In the year 2000 the RCDP established the first sanadiq in 9 villages. Sixty households from these villages that borrowed money from a sanduq in the years 2000 or 2001 and another 60 non-sanduq-members from the same villages were randomly selected and interviewed. Another 60 households from 7 randomly selected villages are used as counterfactuals. Beside the demographic data the formal survey was used to gather data on income, income generating activities, assets, education, food security, and livelihood strategies. These household characteristics, most of them livelihoods assets, were used to calculate composite poverty-indices. These poverty-indices are used to determine the poverty outreach of the project.

The impact of the sanadiq is analysed by Ordinary Least Squares (OLS) regression. The impact for specific poverty categories of households based on poverty-indices can be shown. The paper shows the types of households that profited most and the household characteristics that determine non-access to formal credits even if a sanduq has been established in their village of residence. By analysing farmers perceived limitations of the sanduq from the view points of members, dropouts and non-members, the study presents the conditions under which the sanadiq can operate more successfully.

**Keywords:** Credit, impact, microfinance, poverty, Syria

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## **Risk Perceptions and Risk Management — A Socioeconomic Analysis of Ethiopian Smallholder Coffee Growers**

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In recent years, coffee producers' risk has become one of the major issues in the current discussions within the International Coffee Organisation (ICO) and its member countries. In Ethiopia, coffee growers deal with many risks while often lacking effective mechanisms to manage them. However, information concerning "which sources of risk to coffee income do the growers consider relevant" and "in what risk management tools they are interested in" is too scanty to gain an adequate understanding of their risk behaviour. Therefore, the main aims of this study were (1) to identify the extent and diversity of coffee growers' perceived risks and preferred risk management strategies, and (2) investigate the variables influencing their risk perceptions and management responses. The data used in this study were gathered from a random sample of 195 smallholder coffee growers in southwest Ethiopia. Factor analysis and linear regression have been employed to analyse the data. Factor analysis identifies five latent variables that account for 62 % of the total observed variations in the growers' risk perceptions. Additionally, estimated results from linear regressions indicate that resource endowments, demographics, access to information and location attributes were statistically significant in explaining the observed variation in growers' scores on the underlying risk perceptions (latent variables). In similar manner, factor analysis finds six latent risk management variables and explains about 64 % of the observed variation in the growers' preferences for various risk management strategies. Moreover, estimation results of the linear regression equations revealed that perceived risks, demographics, resource endowments, coffee income volatility, and location were statistically significant in explaining the growers' scores on risk management preferences. Therefore, these information must be utilised to formulate effective and broadly accepted risk management policy and support to smallholder coffee growers.

**Keywords:** Coffee, Ethiopia, management responses, risk perceptions

## **Socio-Economic Assessment of Rainfed Farming Systems in South East Nigeria**

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Increasing population pressure has created the need to bring new land under cultivation. This coupled with, continuous farming and slash and burn system of cultivation have had severe ecological and environmental implications for rural dwellers. The consequences of these, especially in an unstable policy environment, are reflected in household food insecurity and living standard of the families.

Using the farming systems approach, this study characterised farm families based on the criteria for living standard, examined the resource use and resource productivity of farm families and investigates the linkage (interactions) between factors that determine food supply/requirement (food security).

A household survey in four selected regions of Imostate was carried out using standardised questionnaires. The households were initially divided into two clusters based on the availability of family resources. The resulting clusters represent the resource rich (A) and the resource poor (B) which reflects also the different locations of the farm families- those that are in the interior villages and those that are closer to the cities. The population densities of the different study sites are also reflected.

Results show that location, access, ownership and use of resources have an impact on household food security and family living standard. The resource 'rich' appear to be more economically successful than the 'poor' who are located in high population density areas and are basically crop based. They are more remotely located and so have limited access to infrastructure. It further reflects that family resources such as land, have impact on both food supply and food 'requirement'.

**Keywords:** Food supply, food requirement, family living standard, location, policy environment

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## Cost of Illness and Coping Strategies in Rural China

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This study tries to investigate the strategies of households to cope with cost of illness in Southwestern China. A 300-households survey was conducted in Sichuan province in 2002. The strategies for coping with cost of illness was explored by describing coping behaviours, identifying levels at which health risk is coped, analysing the sequence of strategies adoption and making a judgement of success in coping. Results reveal that, though the economic costs of illness inclusive of monetary and time costs of illness is moderate (US\$ 442/HH\*year<sup>-1</sup>) compared with other developing countries such as Ethiopia and Burkina Faso, the share of economic costs of illness in household annual income (29 %) is sufficiently high to adversely affect basic food consumption, and may induce poverty under some circumstances. Whether or not the costs of illness induce poverty depends to a large extent upon the household's capacity of coping with the costs. Findings show that, consistent with previous studies, household is the basic unit of risk coping. Seventy-two percent of illness episodes were successfully financed within households through a variety of strategies such as cash, savings, sale of agricultural products, livestock or other assets. Among ten coping strategies, using cash and savings is most common and transfer from relatives is an important last resort. The extended family played a big role in coping with relatively large costs of illness, with 22 percent of the illness episodes seeking financial aid from households within the extended family. The rural households in Sichuan province adopted strategies from from low-cost to high-cost ones, from within household to the extended family. In general, the coping is successful.

**Keywords:** Coping strategy, cost of illness, extended family

## **Towards Rural Poverty Reduction in Developing Countries — The Role of Public Research and Extension Systems**

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Public research and extension systems will have a key role in implementing the pro-poor agricultural research strategy. Because targeting the poor is not always win-win for growth and poverty elevation, countries that can afford large research budgets, or enjoy significant private-sector investment in productivity enhancing research, will be best placed to undertake this agenda. Where the trade-offs are high, it is appropriate to consider alternative policies for poverty elevation. Technology is only one instrument for helping the poor, and it is not always the most effective one. Its role must be seen within the broader context of rural development and grassroots development efforts. Research needs to be undertaken in more participatory ways if it is to become more effective in empowering the poor. To meet these challenges, there is a need for a more client-oriented, problem-solving approach throughout the agricultural research system, an approach not limited to a particular kind of technology or a particular type of agriculture zone. The concept for participatory innovation development and extension should base on dialogical communication, farmer experimentation and strengthening of self-organisational capacities of rural communities. Encouragement of active participation and dialogue as partners among all actors on the local level, for example, farmers and their institutions, extensionists and researchers are the main stay. Institutional reforms are necessary to change incentive structures within public research and extension systems so that scientists and extension officers are responsive to the needs of their clients. But to be effective, these changes will need to extend to all levels of management. The kinds of changes needed in public agricultural research and extension systems will also require the forging of new partnerships between the public system and NGOs, private sector firms, and farmers.

**Keywords:** Developing countries, extension, poverty reduction, research

## Forests for Poverty Alleviation? — Understanding Household Livelihoods to Better Target Poverty Reduction Efforts

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The World Bank argues that “forests can – and must – take a far greater role in meeting the UN Millennium Summit target of halving extreme poverty by 2015”. But pro-poor forest policies cannot be designed and implemented effectively without basic empirical knowledge, as noted thoroughly in CIFOR’s conference on “Rural Livelihoods, Forests and Biodiversity” (Bonn, 2003). Forests are crucial to the livelihoods of millions of poor people worldwide. But just how important are they, compared to other means of poverty alleviation? To what extent do forests help lift people out of poverty, or are they only useful as safety nets and gap fillers preventing extreme hardship? Which types of forests and products count most for the poor?

An international workshop in Finland (2001) concluded that forests were ignored in macroeconomic Poverty Reduction Strategy Papers (PRSPs), for three reasons: **(i)** lack of basic data on forest-poverty relations, **(ii)** weak understanding among decision makers of the links between forestry and poverty alleviation, and **(iii)** lack of concrete proposals for policy reforms and investment.

This paper presents a project that will directly address the first obstacle — lack of basic data — and significantly contribute to overcoming the two others. The aim of our proposed presentation at the German Tropentag 2004, encouraged by our German partners, is twofold. First, we would like to share and discuss an innovative global-comparative methodology in the growing research sphere of forest-poverty linkages. Second, we aim to broaden and strengthen our German partnerships in the Ph.D. network.

The project will collect high-quality and comparable primary data at the household level on the basis of thorough fieldwork undertaken by PhD students. The majority of the students is to be recruited from developing countries, in order to maximise capacity building impacts in the tropics. The students will be linked to host-country institutions and/or universities abroad as part of a CIFOR-coordinated tropics-wide network. The network currently already includes almost twenty interested Ph.D. students and their respective supervisors.

**Keywords:** Forests, global comparison, household surveys, livelihood, networks

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## How Important Is Growth in National Average Cereal Yield for Raising Food Security?

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Cereal yield is an important indicator guiding the formulation of food policies in developing countries. A recent decline in global cereal yields and cereal production per capita has intensified concerns about future food security. Some authors have claimed that in the light of continuous population growth, greater efforts are needed to boost average cereal yields so to reduce the number of people who are food insecure.

This paper, however, argues that a too strong focus on raising average cereal yield might be counter-productive and deviate from reaching the actual goal of increased food security. Neither is average cereal yield a good indicator of food security, nor does an increase in average cereal yield necessarily go hand in hand with an increase in food security.

In the first part of this paper, we subsequently discuss: **1.)** why national yield statistics should be treated with care; **2.)** why the concept of average cereal yield is more suitable for countries in the temperate regions than for countries in the tropics; and **3.)** why the trend in national average cereal yield is not necessarily compatible with trends in farmers' yields.

In the second part of the paper, we add a fourth argument, namely that the national average yield has become less meaningful over time. Using national and sub-national data for a large number of countries, we show that growth in cereal yield has bifurcated both within and between countries. This bifurcation has important implications for food security because the people who are currently food insecure tend to live in those areas that have least profited from yield increases. Yet, one can take different positions on the implications of — and required policy responses to such bifurcation. We discuss the three most likely of such positions: the theory of comparative advantage, the food sufficiency argument, and the entitlement approach.

We conclude that the relation between average cereal yield and food security is more complicated than frequently assumed. If food security is the goal, than an increase in average cereal yield is too blunt an instrument, and a more differentiated approach is required.

**Keywords:** Cereal yield, food security, food sufficiency, policy

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## **Consumer Preferences as a Guide for Development Strategies for Small Farmers in Chile — The Model Promoted by the Institute of Agricultural Development (INDAP)**

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Small-scale food and agriculture production in Chile involves about 65,000 small companies. They are the main suppliers of fresh produce in national markets and provide about 70 percent of the raw material in the agricultural industry. Small agricultural production requires changes in strategy that allow it to successfully become involved in the opening of trade under the current patterns of economic development based on the increasing opening of trade and development of exports. From this perspective, these are essential in the business development of this sector: first, the law of supply and demand; and, second, making the most of its comparative and competitive advantages. Meeting the Chilean Agricultural Policy supported by the advantages that the country offers, the strategy of differentiation based on quality can be seen as the best option for competitive development of the country's food and agricultural sector. This strategy aims to move the centre of national agricultural activity from commodity supply to a specialised supply with large degrees of differentiation in which the determining factors would be qualities of innocuousness and value, as an answer to what today constitutes the standard of consumer use and preference in foreign and domestic markets. The ability of small agricultural companies to react and successfully face this process of transformation in the markets is mediated by a long series of structural deficiencies and market imperfections. Considering the social significance and economical contribution that this sector makes to the harmonious development of the country, Chile has assumed the task of creating conditions and opportunities for all the participants that operate in the chain and that offer competitive potential. The objective of the study is to present the operating proposal and analyse the main results of the sector policy implemented by the Institute of Agricultural Development (INDAP-Ministry of Agriculture) at the level of small-scale agricultural production, with regards to the development of a competitive development strategy based on consumer demands.

**Keywords:** Agricultural policy, consumer preferences, food safety and quality

## **Can Social Accounting Matrix (SAM)-Based Models Serve as Appraisal Tools for Large-scale Infrastructure Projects? — A Provincial CGE Approach for Vietnam**

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Large regional disparities persist in Vietnam, with a poverty rate of 68 % in the north-western mountainous region compared to a national average of 28.9 % (Joint Donor Report, 2003). To confront these inequalities and to lay the foundations for concerted regional action, the national Comprehensive Poverty Reduction and Growth (CPRGS) strategies will be rolled out to the provincial level and to the planning large-scale public investment projects. An economy wide model is highly desirable to assess the effectiveness of targeted policies and the efficient use of public financial resources. The social accounting matrix (SAM) is a powerful tool for this kind of socio-economic analyses. Our contribution presents a recent SAM (year 2002) for Son La, one of the poorest provinces in the northern mountainous region of Vietnam. It reveals linkages between 22 production activities, 26 commodities, 3 factor endowments and 10 institutional accounts and serves for descriptive as well as a basis for computational analyses. It is the first provincial- level SAM in Vietnam and a step forward towards the use of this framework for regional poverty reduction strategies. In this context we depart on the use of SAMs as a tool for large scale projects appraisals. It can be shown that this approach has the potential to serve as an effective supplement to project- based and statistical approaches. In the case of Son La, construction of a hydroelectric power plant with an investment volume worth 15 times annual provincial GDP starts in 2005. Preliminary results find great poverty reducing potentials through direct and much more through indirect effects. Construction and transportation services, sectors with presumably high growth rates in the context of infrastructure development, both have large multiplier effects. For each currency unit (CU) of increased demand in these two sectors, demand for agricultural products are estimated to rise by 0.39 and 0.46 CUs. Households could generate an estimated additional income of 0.7 and 0.8 CUs respectively. Further research will extend the multiplier model to a dynamic CGE model and substantiate the scenarios. Results will be available by the time of the Tropentag conference in October.

**Keywords:** CGE, Infrastructure, Investment, PRSP, Social Accounting Matrix (SAM)

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## Chances and Strategies of Scaling-up Processes in Sustainable Agriculture Projects

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“SUSTAINET – Sustainable Agriculture Information Network” is a joint project of the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) and various German NGOs addressing the problem of increasing poverty worldwide, the expected food deficit in developing countries, and the need to produce food with ever fewer natural resources. Initiated by the German government’s Council for Sustainable Development a project term of six years (October 2003 to September 2009) is planned for “SUSTAINET”. Experience gained in development cooperation and scientific studies worldwide indicates that locally adapted sustainable agriculture systems can make a key contribution to alleviating hunger. To date these approaches and concepts for sustainable agriculture are available on a local basis, but there are barriers to their implementation and dissemination. Often, the political, social and economic framework conditions prevent adequate consideration being given to the experience on hand. Framework conditions can be distinguished into internal and external factors. Internal factors, which can be directly influenced by partners involved in the process, are for example seasonal, cultural or psycho-social constraints whereas external factors such as unfavourable climatic, natural conditions or political instability cannot be influenced directly. The overall objective of “SUSTAINET” is to systematically evaluate possible scaling-up processes of sustainable agriculture concepts by compiling structured information on success factors and dissemination constraints. Suitable best concepts are in a next step promoted: In cooperation with local intermediary organisations these strategies will be implemented and disseminated in selected pilot regions in three continents (Africa, Asia and Latin America). Impacts are anticipated on three levels. First of all local project partners will make a significant contribution to alleviate hunger in the priority countries through the dissemination of best practices in locally adapted agriculture. Then, on a scientific research level, the scaling-up approach will be advanced by further defining the framework conditions for successful scaling-up of agriculture projects. Lastly, recommendations concerning promising development strategies in the agriculture sector will be made to national and international decision-makers.

**Keywords:** Best practices, scaling-up, sustainable agriculture

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## **Causes and Consequences of Low Farm Income and Land Use Change — Agro-socio-economic Approaches in the Northern Ecuadorian Amazon**

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There have recently been a number of important studies on agricultural systems, land-use and land-cover change and their environmental impacts on deforestation and expansion of the agricultural frontier, especially in tropical rainforest areas of developing countries. However, there have been almost no studies of the rural poverty of households in the study regions. It is also interesting to examine and understand the degrees to which income levels are related to deforestation and land use. This could contribute to the development of better policies to reduce rural poverty and improve the welfare of settler household, who are among the poorest in the country. The research to be reported on in this paper will be based on data from a detailed survey of migrant settler households in the Ecuadorian Amazon, collected from 1990 to 1999 by the University of North Carolina (UNC) and collaborating institutions in Ecuador. The detailed data collected permit the analysis of agricultural systems, land-use change and incomes of migrant colonist farm households in the northern three provinces of the Ecuadorian Amazon. This has been the main region of agricultural colonisation by migrants in Ecuador since the 1970s, following the discovery of petroleum in 1967. This paper sheds some light on the agro-socioeconomic situation, of those migrants. We first describe the data collection process and procedures used to estimate household incomes. We then provide basic data on settler household characteristics, including migration background, education, household size, plot size, land ownership and household incomes. The population in the study region has been growing rapidly, which is associated with substantial subdivision and fragmentation of plots in the 1990s, causing important changes in land use, off-farm employment, and household incomes. The latter will be compared for 1990 and 1999 to assess the causes of changes and develop policy recommendations for reducing rural poverty in the study region.

**Keywords:** Agricultural systems, Amazon, colonisation, farm household income, Ecuador, land use change, migration, rural poverty

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## **Conflicts, Entitlements, and Natural Resource Management in the Yerer Valley, Ethiopia**

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In view of remaining ambiguities in the literature on common-pool resources (CPR), this paper makes a twofold argument: first, it proposes a methodology to study the emergence of institutions that govern CPR use employing the analytic narratives approach which combines game theoretical reasoning with empirical narratives and thus combines inductive and deductive research methods. Secondly, we want to bridge the gap between efficiency and equity considerations in the CPR literature. Given the ecological constraints and the variation of resource users over space and time, institutional arrangements for resource governance may be ad hoc, ambiguous and overlapping. Hence, it may be particularly useful to study processes of entitlement mapping and the negotiation over resource access, because this can illuminate how institutions of resource governance come into being. We will analyse a case study of conflicting resource claims to grazing pasture in the Yerer/Daketa valley in eastern Ethiopia under conditions of particular resource scarcity (drought) where outsider pastoralists seek to encroach grazing resources which are customarily claimed by the agro-pastoralists inhabiting the valley. In fact, pastoralists enter in the agro-pastoralists grazing resources without violence occurring, although the increasing resource pressure harms livestock assets of the agro-pastoralists. We develop a sequential game-theoretical model which suggests the following explanation: Asset-poor members of the agro-pastoralist community in Yerer/Daketa valley without own livestock enter in mutual agreement with outsider migrant pastoralists and trade their resource entitlements against asset transfers. This agreement weakens the bargaining power of livestock owning agro-pastoralists who become more reluctant to fight. The theoretical propositions of the model will then be validated and confined based on empirical narratives consisting of a survey of 78 randomly selected households as well as focused group discussions in the study area.

**Keywords:** Common-pool resources, conflict, Ethiopia, pastoralism, resource access

## Adverse Selection Problems in Developing Country Factor Markets — Fertilisers in Cambodia

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Developing country factor markets are often fragmented and inadequately reflect supply and demand conditions. Studies analysing agricultural factor markets in developing countries have cited information deficiencies as an important reason for factor market inefficiencies. In this paper, we analyse the presence and potential impact of low quality fertilisers, inadequate access to credit and market information on fertiliser market participation and application rates. We explain using game theory that bad quality fertiliser negatively affects the market for higher quality fertilisers. It deters all buyers not willing to pay the market price for the average quality fertiliser available. Empirically, using data from a survey of 82 farmers in seven different regions of Cambodia, we show that farmers chose to abstain from the fertiliser market altogether or decrease their application rates below recommended levels. First, we estimate a logistic model to test the significance of factors influencing the decision to abstain from the fertiliser market including prior experience with low quality fertilisers (adulteration), inadequate access to credit and regional market participation. We confirm positive relationships between the decision to abstain and the credit and adulteration variables. We also confirm a negative impact of regional market participation because regional traders are thought to be relatively trustworthy when many other farmers in the region also choose to participate in the market. In a second, multivariate regression, we estimate the impact of the indicators for adulteration, credit access, and whether farmers have access to market information as well as a categorical regional dummy variable on urea application rates per hectare. Adequate access to credit and adequate market information both increase urea application (by about 29 and 32 kg per ha, respectively) whereas having obtained bad quality fertilisers in the past (adulteration) decreases urea application rates (by about 22 kg per ha). The regional impacts amount to decreases in urea consumption between 40 and 60 kg per ha relative to the base region (Kandal).

**Keywords:** Adverse selection, asymmetric information, quality

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## Differences in the Nutritional Situation of Population Groups as a Factor of Conflict Risk? — The Case of Dagara and Fulani in South-west Burkina Faso

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According to FAO (2003), 17 % of Burkina Faso's population are undernourished (1999–2001). In the South-Western regions, the nutrition situation is even worse: 30 % of children under five are severely malnourished (weight/age < -2 SD), and 25 % chronically malnourished (height/age < -2 SD). The insufficient nutritional situation has to be seen in the context of migration by parts of the population from the northern sahelian provinces strongly affected by desertification towards the more humid and less populated southern regions. This study compares the nutritional situation of immigrated Fulani pastoralists and the autochthonous Dagara farmers in two research villages situated in the Poni province. Based on previous studies about land conflicts, the consumption of food in terms of energy and proteins and the expenditures for food and non-food commodities according to different seasons were investigated in 20 % of all concessions. The applied methods were: 24 h-recalls combined with weighing, semi-structured interviews, observation of local markets.

Results show that in both villages, nutrition is insufficient in quantity and quality. The mean dietary energy supply during dry season was less than 2200 kcal/day per person and didn't achieve the recommended energy requirement. Especially during rainy season (mean dietary energy supply of 1700 kcal/day per person), the daily alimentation was not secured, since the stocks from the last harvest were too small, and the additional off-farm-income did not allow buying sufficient amounts of staple food, meat or legumes. Compared to the autochthonous population, the immigrated Fulani had advantages: The higher income generated through cattle commercialisation resulted in higher expenditures for food commodities; also the direct access to food of animal origin rich in proteins and micronutrients was generally higher. These differences can contribute to reinforce already existing conflicts between the two ethnic groups.

The encouragement of the commercial- and exchange-activities between Dagara and Fulani (exchange dung — fodder, commercialisation of milk products, additional incomes for Dagara farmers by working on Fulani fields) can supply the nutritional situation's improvement. On the other hand, such activities can contribute to reduce the conflict risk.

**Keywords:** Burkina Faso, conflicts, household expenditure, nutrition

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## **Gender Discrimination and Its Impact on Food and Nutrition Security in Kenya — A Case of West Pokot District**

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Gender equality and empowerment of women is one of the effective ways to combat poverty, hunger and disease, and to stimulate development that is sustainable. The government of Kenya has made efforts to promote women's active involvement in all areas of societal development, in addition to ensuring that development is based on the contributions and concerns of both men and women. Despite these efforts, there are still clear gender inequalities in areas where both men and women's roles are visible, for example in health, education, agriculture and in some remunerated work.

The aim of this paper is to assess the social and economic costs of gender discrimination; these costs are incurred in suboptimal resource allocation, in lost agricultural productivity and in deficient nutrition of household members. The study is motivated by the fact that despite women playing an important role in agricultural production and in ensuring good nutrition for household members, many women in Kenya do not have the same access to resources like men do. This study argues that: with the same access and control of productive resources by both male and female headed households in a given geographical area, the levels of agricultural productivity and nutrition outcomes in male headed households should not be significantly different from those of female headed households. Any difference would be attributed to differences in access to resource caused by gender discrimination.

The study analyses the food and nutrition situation in female and male headed households in relation to access to human capital, financial capital and land. The results show that human and financial capitals are the main resources that caused variations in both agricultural productivity and nutritional status in the two categories of households. Despite male headed households having access to more land than the female headed households, there was no significant difference in average area of land cultivated in the two categories of households. Economic cost analysis of unequal access to resources by gender is done using an econometric model.

**Keywords:** Access to resources, food and nutrition security, gender discrimination, Kenya

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## Forest Management between Conservation and Poverty Alleviation

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In Madagascar, the management of forest resources is framed by widespread and extreme poverty and a continuous loss of the country's unique biodiversity. As a response, the government of Madagascar has adopted conservation as the guiding principle for natural resource management. The decision is based on the results of macro-economic studies that emphasise economic values such as biodiversity, recreation, and watershed protection. In addition, these analyses suggest that it is especially the poorest people who benefit most from the conservation of natural resources. However, the success of this conservation strategy is planned to be measured mainly against progress made in reducing the present rate of deforestation, but not against indicators of economic development and poverty alleviation.

Therefore, it is the purpose of this study to carry out an economic analysis of alternative forest management strategies from the viewpoint of rural household in Madagascar using cost-benefit-analysis. In this context, this study places significant interest on a detailed exploration of the complex socio-economic and socio-cultural environment framing the decision-making process of natural resource utilisation by rural households. In addition, economic aspects at the household level are combined with natural science data of forest resources to analyse the interdependence of ecosystem dynamics and economic decision-making processes. This extends the analysis beyond mere economic aspects of resource management and it provides further information how alternative management strategies can meet the increasing direct demand on forest resources, while also achieving the objective of biodiversity conservation. One emphasis of this research project is to analyse the potential of alternative management strategies to contribute to the overall goal of poverty alleviation in Madagascar taking into account the subjective welfare judgement of the individual rural households. The quantitative analysis is complemented by a discussion of qualitative research results that are judged important to be taken account of whenever policy measures are designed in the future for achieving sustainable forest management. The emphasis of this study is to analyse the potential of alternative forest management strategies to contribute to the overall goal of poverty alleviation.

**Keywords:** Biodiversity, conservation, cost-benefit-analysis, forest management, poverty alleviation

## Forestry in Tripura — Case Study of Resource Access and Conflicts

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This paper presents a historical and an analytical account of the struggle for dominance and changing dynamics of access control in various phases of forest use. The history of forestry in Tripura has been marked by a struggle for dominance. A diagonally opposed production–consumption need, of the forest based people and the state, constitutes this struggle. To facilitate the analysis, the historical spread of the struggle has been divided into four periods, namely pre-commercial period before 1887, initial period of commercialisation 1887–1950, scientific forestry–period of commercialisation 1950–1990 and joint forest management period after 1990.

The first phase is characterised as a period when forests and forestland were abundant to meet the needs of the primitive society. The access to forests and forestland was open to anyone who wanted to use it. In the second phase the State started its efforts to dominate the forests. The tribal people and peasants were marginalised and their traditional uses of forest and forest resources became criminal act and illegal. In the third phase while the State continued to increase its domain, the resistance of the tribal people and peasants also intensified. The State used various mechanism including legislation and police force to retain its hold on the forests. The tribal people and peasants responded with their own overt and covert resistance in coalition with politicians and other wings of the functionally divided state.

The apparent effects of degradation brought the realisation among the warring actors to resolve the struggle. There was a policy shift based on participatory system of management, founded not on mutual antagonism but on a genuine partnership between the state and its citizens which immensely improved the situation. It is concluded from this case study that there is a necessity of evolving new institutions tailored to meet the requirements of different situations which will ensure local people's participation as well as the use of experience and support for the forest department so that both local people and the State can work together rather than at cross purposes.

**Keywords:** Conflict, forest management, resource access



## **Land Allocation in Forestry in Northern Vietnam — Processes, Local People's Perception and People's Use of Forest Land**

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In the period between 1975 and 1995, forest resources in Vietnam degraded rapidly. Increasing pressure on land and poverty have been the main problems with negative effects on sustainable land use in Vietnam. To address the problem of rapid deforestation, the government from 1993 onwards formulated policies regulating forest land allocation to households. These policies are based on the assumption that households, if they receive the of forestry activities benefits, will protect and develop forests. However, the forest land allocation process has been slow and the effect on reforestation and conservation unclear. The objectives of this study are to assess the forest land allocation process to households and its determining factors, understand local people's perception of the forest land allocation and appraise the effect of the forest land allocation on forest land use.

The results of the study show that at present, only about 50 % of the households in Vietnam eligible for forest land allocation have actually received forest land. The farmers' income and living conditions in the study area are low, with an average household income of 515 US\$ per household per year. With an average family size of 5.9 persons/household per capita incomes are below the poverty level of US\$ per day. Also, the education level is low with 56 % of household heads having attended primary school education and 26 % being illiterate. The forest land allocation is still proceeding; however, expectation concerning forest land policies is not high among farmers. Nevertheless, reforestation has taken place and the forest area, the quality of forests has improved. Multiple linear regression models were used for analysing the impact of several factors on forest land allocation and household income. The results indicate that the forest land allocated to households depend mainly on a household's forest practices, the forest situation and farmer's participation in forestry projects. The forest land allocation has had a positive effect on household income at significance level of 1 %. The study concludes that forest land allocation to households has induced local people to play positive roles in forest protection, management and has increased incomes of participating rural households .

**Keywords:** Allocation, forest land, household, land use

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## **Integration as a Precondition for Socio-Economic Welfare of Rural Migrants in the Bolivian Oriente**

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Internal rural migration is a demographic phenomenon which affects the eastern Bolivian lowlands mainly in two different ways. On the one hand the migrations provoke a profound modification of the landscape by exploitation and potential degradation of the natural resources. On the other hand massive inflows of migrants cause the transformation of the local society. Intensity and dimension of those modifications depend on the level of integration of the individuals and groups which are involved. Consequently, the inclusion of the actors into the social system (social integration) as well as the relationship between the parts of the society (systemic integration) determine the societal as well as the ecological equilibrium.

An empirical analysis of the integration process of migrants from the Andean highlands was realised in the colonisation area of San Julián, Dpt. of Santa Cruz, Bolivia. One main aspect of the investigation focused on the rural poverty and different standards of living of migrant and local households. Empirical data were collected through semi-structured interviews as well as standardised interviews in two villages (98 households).

The results show a latent correlation between social integration and individual management of common natural resources. A high degree of personal integration about the four dimensions of social integration, which are “cultural adaptation”, “positioning”, “interaction” and “identification” (ESSER, 2001), encourages the sensitivity for common socio-economic welfare through specific livelihood strategies. The current situation in the research area is characterised by the fragile systemic integration of the colonisation area into the regional economy and society. This fact complicates not only social integration and intercultural living together between migrants from the Andean highlands and the lowland people, but also threatens the ecological balance of the region. Consequently, without the political and civil intentions to resolve the systemic disintegration there will not be a sustainable socio-economic development.

**Keywords:** Bolivia, Integration, Migration, Rural Poverty, Welfare

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## **Cultural Aspects of Rural Poverty — Empirical Analysis on Access to and Use of Land in Central Sulawesi, Indonesia**

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The transformation of rural regions is depending on the modernisation process of a country as a whole. That means rural poverty is to be seen in the national socio-economic context. If we take the Human Development Index of UNDP to measure the development process of a country the situation in Indonesia has become slightly better from 0.677 to 0.684, but relatively worse in the world wide ranking. Indonesia fell from rank 102 (1999) to rank 110 (2000). Despite this generalised numbers we find great disparities in rural Indonesia, especially between high productive islands like Java and more extensively operated regions like Central Sulawesi. Even on local level we find an enormous disparity of welfare.

Income and welfare of the rural community are based on the natural resources, but the decisive factor for the income of the individual households is to share the potentials. Thus the access to land and the abilities of land use determines the household's socio-economic welfare. The access to land and the use of the land on the other hand is depending on a variety of socio-cultural factors. Our study focuses on the cultural factors, which describe particular shared values, beliefs, knowledge, skills and practices that underpin behaviour by members of a social or ethnic group. 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. Using a quantitative village census, the study reflects the impact of cultural factors on the socio-economic stratification of three villages in Central Sulawesi. The empirical evidence reveals the decisive relevance of cultural aspects in terms of individual poverty. The stratification is derived by applying on the Poverty Assessment Tool (ZELLER *et al.* 2003).

**Keywords:** Central Sulawesi, culture, Indonesia, land use, poverty

## **Migration, Population Growth and Forest Conversion — Exploring the Link on the Village Level**

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The degree of forest degradation and conversion of forest inside and bordering Lore Lindu National Park in Central Sulawesi, Indonesia varies considerably. The commercial extraction of timber and rattan and the permanent conversion of forest into arable land is much higher in villages that have experienced rapid and high population growth. However, the simple formula “rural immigration equals deforestation” obstructs the view on the complex multi-causal relationships underlying deforestation. Based on the analysis of semi-structured interviews with selected households in several villages in four districts we emphasise the necessity to examine the reasons why migrants move to certain villages but not to others. Generally speaking, affluent migrants from other provinces are attracted by the relative ease to purchase fertile land in certain villages. In these particular villages the community forest has nearly vanished completely. Plots are cleared by locals first in order to establish ownership rights and are then sold to migrants. While the latter have the means and knowledge to invest into labour extensive cacao cultivation, which is rapidly becoming the dominating cultivation system, the former face difficulties to seize the benefits of the cultivation of perennial crops. The national park authority fails to control illegal logging organised by members of the village leadership, that constitutes the inroad for clearing forest for fields. It is important to note that it is not the migrants who initially establish plots inside the national park. Rather locals open these fields and then may sell them to the migrants. Often the aforementioned village leaders are involved in these land transactions, conveying the impression to the migrants that these are legal arrangements. In contrast, in other villages the local leaders support the national park and aim at preserving the community forests. As they actively restrict the further conversion of forest resources they put a constrain on the amount of land available to migrants, making their village less attractive for newcomers. With mounting market and population pressures and lack of enforcement by the central state, it depends on local governments and institutions’ to which extent migration can lead to forest conversion in their village.

**Keywords:** Forest conversion, local institutions, migration

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## **The Role of Rwandese Women in the Agricultural Production with Special Consideration of the Soil Scarcity and the Civil War**

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Allowing for equal opportunities of women and men is an important priority of development projects. In developing countries, the contribution of women to food production and development of the whole agricultural sector is very significant. Several studies conducted in the middle of the eighties showed that approximately 98 % of rural women classified as economically active were engaged in agriculture. However, women have been underprivileged by their tradition in many developing countries and their role has been underestimated. It took a long time until agricultural policies and programs responded to inequality between men and women concerning the access to and control on productive factors.

Rwanda is classified as an over-populated small country in central Africa with a population of more than 8 million inhabitants and a total area of 26,338 km<sup>2</sup>. Due to demographic pressure on farmland, this country has a quantitative and qualitative deficit in food supply since the middle of the eighties. The situation deteriorated through the civil war in 1994. Although the war led to a predominance of women in most of economical sectors, especially in agriculture, the Rwandese tradition has disadvantaged women and emphasised the superiority of men. This led to a crucial inequality in the distribution of production factors, of land in particular. In all agricultural activities, women had to address themselves to decisions of men. This made it difficult for women to initiate potential innovations in agriculture.

The principal purposes of the investigations are the analysis of the food situation in Rwanda according to population growth and agricultural production, and the evaluation of the achievements of Rwandese women as new heads of agricultural production units. Interviews, group discussions with the agricultural population and expert interviews with different organisations were conducted in co-operation with the CSC (Centre de Services aux Copératives de Gitarama). The primary results show that Rwanda still has possibilities to increase agricultural production (through irrigation, resettlement, crop regionalisation, improvement of market system etc...). Since the civil war in 1994, when women got advice on new technologies, they use them more effectively than men.

**Keywords:** Agroproduction and population growth, cooperatives, land scarcity, food security, Rwanda, women, new agricultural technology

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## **Livelihood Strategies of the Rural Poor in Indonesia — Evidence from Transmigrant Villages in Central-Sulawesi**

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The resettlement scheme transmigrasi has the objectives to decrease poverty and unemployment in the overpopulated areas of Java and Bali and to improve living standards for the transmigrants. But most selected families belonged to the landless poor and it has been argued that the poverty was only transferred to the outer islands through resettlement. These critics point out that in many cases the natural potential of the chosen resettlement sites were low and the preparation insufficient. The empirical findings of our research in two transmigration settlements in Central Sulawesi justify the general conclusion that integration of the migrants mainly from Java and Bali has not been achieved. In both villages out-migration set off shortly after the resettlers had arrived. The persisting households employed a variety of strategies, including off-farm activities and forest clearing, to secure their livelihoods. The encroachment into the national park and the clearing of secondary and primary forest is the outcome of failures in project planning, implementation, and maintenance. If in addition the financial and material support for the resettlers is not provided the struggle for survival leads to unsustainable use of the resources without another choice. Furthermore the migrants are in an inferior political position. Due to their status as ‘migrants’ they lack bargaining power in negotiations with the local communities. This has an impact on the use of the natural resources because they were not able to cultivate their allocated land and secondly, they were forced to move to another location in the primary forest. Additionally off-farm activities played an important role to secure the livelihood of the transmigrants. One major off-farm source of income has been wage labour on a nearby tea plantation. It provided the minimum income the settlers needed to survive until they could obtain the first yields. Farm labour on the fields of other farmers in the settlement or in the surrounding villages has been another way of gaining additional income. The Balinese could moreover benefit from the network of Balinese communities in Central-Sulawesi where they found the opportunity to work as farm labourers.

**Keywords:** Migration, Central Sulawesi, Indonesia, livelihood strategies, rural poor

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## **Traditional Risk Prediction and Prevention Strategies in the San Pedro Catchment Area, Potosi, Bolivia**

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Traditional farming systems depend particularly on their natural resource basis. They have developed measures to cope with natural hazards to prevent damage from their resources and agricultural production. However, especially in developing countries the globally recognised depletion of natural resources is tangible because it is having fatal consequences on the livelihood of indigenous people.

The study has been carried out in the catchment area of the San Pedro River, North Potosí, Bolivia. The objective of the study is to identify and evaluate traditional knowledge and mitigation strategies for natural hazards that occur in the area. Two villages in representative locations were selected for the data surveys. Questionnaires were developed by extensive literature review and key person interviews. They were tested in pre-surveys. In total 60 farm-households were interviewed. In addition participatory observation was used to achieve a greater understanding of the employed strategies. High pressure on the natural resources in the area stems from the interplay of natural hazards and limited access to land. The farm-households could be grouped according to their income. The main coping strategy to a disaster for the high income group is a diversification of the income sources, which is not possible for the low income group.

In both researched communities labour intensive traditional soil conservation techniques as well as other risk prevention and mitigation strategies are still carried out. But while they were successful in the past they are less appropriate due to unsafe socio-economic conditions in the current situation of the households. The main reason for their limited application is the high opportunity cost for installing these measures. Practices of agroforestry with the purpose to halt wind and water erosion, fight drought and stabilize the microclimate are applied inconsistently. Other promising techniques such as fencing livestock, intercropping, rotations of crops, spatial distribution of production and contour farming are only carried out by some of the farmers. Mechanical techniques such as water diversion ditches and canals and retention terraces to save water are the most commonly applied techniques. There is a high need to support sustainable solutions to improve the production system in order to prevent a shift of the household problems into the poverty zones of the cities.

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**Keywords:** Bolivia, farm household, prevention strategies, risk



## Conflicting Uses of Natural Resources and Derived Problems in Mangrove Forest Remnants in Peru

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This review analyses the current conservation status and the problems associated with the mangrove ecosystem in relation to land tenure and the way people use the natural resources. Mangroves are highly productive ecosystems, but very fragile as well. They have been subjected to intense use mainly from the aquaculture industry. The study has been done in the National Sanctuary “Los Manglares de Tumbes” (NSLMT) located in northern coastal Peru (Department of Tumbes). This area represents the southern distributional limit of mangroves in the eastern Pacific Ocean coast. The National Sanctuary is the second highest protection category within the National System of Natural Protected Areas supported by the Peruvian Government. Over the last 30 years, positive and negative factors have influenced this unique ecosystem in Peru. Many different actors play important roles in this ecosystem and sometimes contradicting activities are carried out, resulting in severe conflicts. Severe negative impacts are caused by anthropogenic activities, enhanced by the fact that laws are not well defined, the poverty of local people, the lack of an effective control by local governments and unequal conservation and management objectives among the different institutions involved with the natural area. This wealth of actors and situations show how complex the management of the NSLMT is. Additionally, no long term basic or applied research is done, not even by local universities and NGOs. Without the necessary data it is difficult to manage sanctuary. As a result of the present analysis, more and better science is required, as well as the improvement of the relationship among the involved actors in the NSLMT to successfully manage and conserve it.

**Keywords:** Conservation, land tenure, management, mangroves, natural resources, resource utilisation



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## **Are Local Institutions Blessing or Curse for the Poor? — The Case of Dairy Sheep Systems in a Dry Marginal Area of Syria**

MALIKA ABDELALI-MARTINI, ADEN AW-HASSAN

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Local institutions of dairy products play an important role in providing services to the rural poor, such as marketing, input supply, credit and safety nets against unexpected shortfalls due to drought or crop and livestock losses. Hence they play a critical role in the livelihoods of the rural poor. However, the benefits of participating in local institutional arrangements may be uneven and the poor may be disadvantaged because of their weak negotiating position and vulnerability. This study covers 44 villages in Khanasser valley, a dry marginal area located in northwest Syria, where sheep production is a dominant source of livelihoods. The study describes local institutional arrangements in relation to the dairy sheep system and the embedded social capital. Using qualitative and quantitative methods, the study analyses the terms of arrangements between traders and dairy sheep producers in milk collection, processing and marketing. The distributional effects of these arrangements and the factors influencing the poor's access to these institutions are analysed. The results show that important services are provided to the poor particularly in the absence of infrastructure and access to markets. It was found that different communities use different strategies to process and market dairy sheep products with associated benefits. The internal and external factors that determine farmers' choices of these different strategies are analysed. Since sheep production activities are highly gender specific, the impact of these different strategies on women's well-being is examined. This provides insights into the feasibility of gender-specific technological improvements in the dairy sheep sector. The study provides recommendations for technological and development options to improve the dairy sheep production system in similar marginal dry areas.

**Keywords:** Arrangements, dairy processing, gender, local institutions, milk production, social capital

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## Traversing the Course for Collective Forestry in Southwest China — A View from Yunnan Province

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More than twenty-five years since the advent of sweeping economic reforms, forest policy in China continues to face two primary investment challenges. The first, increasing government and private investment in forest production, is necessitated by an enormous discrepancy between China's supply of and demand for forest products, as well as by the substantial role that forests must play in the development of the country's rural areas. The second, increasing government and private investment in forest-based environmental services, is a response to a deteriorating forest resource base, particularly in the ecologically sensitive upland watersheds of the China's Southwest. These competing needs to commercialise and conserve have created an as yet unresolved incongruity between productive and environmental forestry. At the heart of this tension are the country's collective forests and their owners % predominantly villages.

Since forestry reforms in the early 1980s, more than half of China's forests have been collectively, as opposed to state, owned. Although reforms, begun in 1983 and modeled on similar reforms in agriculture, were intended to decentralise management for collectively-owned forestland and barren lands to individual households, a significant portion of China's forests remain collectively managed. In other areas, forest management that was devolved to individual households, owing to the prohibitively high operational costs of managing smaller, often non-contiguous plots, has been returned to some form of collective management (LIU, 2001).

As the efficiency drawbacks to individualised, fragmented forest management begin to become more apparent (SCHWARZWALDER *et al.*, 2001), China will be forced, either implicitly or explicitly, to choose among social models for forestry % ranging from larger, corporately held plots to smaller-scale forms of community-based management. Equity implications notwithstanding, in ecologically significant areas, such as the country's mountainous Southwest, small-scale collective forest management can provide more reliable and redundant biodiversity and watershed services than large-scale corporate forestry. There is a continued role for collective forestry alongside state forestry in China's Southwest, and the appropriate question is thus not whether but how local villages can manage forests for specific regional environmental services. As argued here, the success of collective forestry in Southwest China will ultimately be determined by continued investment in local institutional reforms, changes in extension services to support small-scale forestry, commitment to more effective multi-scale governance, and overarching policy support to collective forestry.

This analysis explores the prominence of these four themes % village institutions, line agency support, multi-scale governance, and policy backing % in collective forestry in four villages in Southwest China's Yunnan Province, drawing on evidence from other

**Keywords:** China, collective forestry

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## **Institutional Dynamics and Natural Resource Management — A Study of Socio-economic and Ecological Impact of Joint Forest Management in India**

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Since the mid 1980s devolution and decentralisation of natural resource management has become a policy tool for many developing countries across the globe. Countries have devolved and decentralised their resource use and management system to the users. The apparent change in policy from the state-managed top down approach to the community level is fuelled by the recognition of the limits of government agencies in managing resources at the local level, which has resulted in massive degradation of natural resources and of local people's livelihood systems. India has been at the forefront of devolving natural resource management to the local community, particularly in the forestry sector, since more than a decade. The 1988 forest policy was a landmark in the history of Indian forest policy which for the first time recognised the importance of community involvement in the forest management for improvements of their livelihood systems and protection of forest resources. In a follow up document issued in 1990, Central government issued guidelines to all the state governments to implement 'Joint Forest Management Systems' by devolving everyday forest use and management rights to the community. Accordingly, almost all the States have formally resolved to implement JFM, making it one of the largest of such programs in the world. This paper makes an attempt to assess the institutional, economic (livelihoods) and ecological (forest conservation) outcomes of joint forest management. For this, an in-depth study conducted in a fringe village in Indian state of Andhra Pradesh, where joint forest management programme has been initiated since 1996. The study reveals that the community got benefited immensely from the JFM programme in terms of wage labour and income generated from the collection of non timber forest produce (NTFP) which has helped the community to overcome the distress of poverty. The forest growth during this period is excellent due to strong community protection. In the institutional front the Forest Department completely failed to provide appropriate technical know-how to carry out the forest management activities and legal support for resolving conflicts (customary rights problems) with neighbouring villages, that is crucial for the sustainability of the program.

**Keywords:** Andhra Pradesh, India, institutions, Joint Forest Management

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## **Wild Arabica Coffee Populations under Sever Threat – Farmers’ perception of Existence, Access and Conservation Needs of Wild Coffee in Montane Rainforests of Southwestern Ethiopia**

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In Ethiopia, wild arabica coffee populations have been used for hundreds of thousands of years. Thus, it can certainly be assumed that farmers have played a significant role in the distribution, population dynamics, conservation and management of the wild coffee. However, the role that farmers have played so far and their contribution towards the existence of the wild coffee has often been regarded, at least according to outsiders, as negligible. The age-old traditional coffee production practice, accompanied of course by unabated deforestation, has in particular been regarded as a major threat contributing to the existence of the wild coffee. A study was conducted with an aim to analyse farmers’ resource utilisation behaviour and the influence it has on wild coffee conservation. The study gave particular emphasis to understanding farmers’ perception of the reasons for the existence, the population dynamics, the threats to, the conservation need, and the strategies to conserve the wild coffee population in the forest. The result indicated that considerable variations were observed among farmers in terms of social factors such as age, education, family size, length of stay in the locality, religion and ethnicity. Such variations in turn have resulted in creating variations in resource utilisation behaviour among farmers themselves on the one hand and perception differences as regards the conservation need of the resource between outsiders and farmers on the other. Variations have also been observed among farmers themselves and between farmers and outsiders as regards the reason for the existence of, the population dynamics over time, the threats to and the conservation need of the wild coffee in the forest. Therefore, prior knowledge as regards the role that contemporary practices and attitudes play in exercising rights (social structure, power relations, resource ownership and rights over resources, responsibilities) by taking into account the social differentiations is significantly important as it plays a role in designing and implementing effective conservation and use concepts.

**Keywords:** Conservation, farmers’ perception, wild coffee

## **Factors Influencing Local Forest Institutions — A Case Study of Forest Devolution in Central Highlands of Vietnam**

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Devolution programme that transfer authority and management responsibility for forest resource management from government agencies to local users are often seen as a promising solution to protect forest resources. Following this trend, over the last two decades forest agencies around the world have largely pursued devolution initiation. Devolution (or forest land allocation as it is called in Vietnam) is expected that local forest institutions would be changed and forest resources would be better protected. Factors of devolution motivating local user's to change local forest institutions are not often well understood, however.

This study suggests that devolution without enough attentions paid to the roles of existing local institutions, often create conflicts between local institutions and devolution policies. Because of the mismatch between local and legal institutions, the costs for transforming the local rules are costly and benefits which could be obtained from devolution are very limited. Due to this obstacle, it finally makes devolution policies cannot be translated into the rules-in-use, and devolved forest resources are continuously declined after devolution. The study suggests that devolution can obtain its objectives unless devolution policies match local forest institutions.

This empirical study is based on a three year research project funded by Tropical Ecological Support Program (TOEB2) in the German Agency for Technical Support (GTZ). The study's aim is to assess the impacts of forest devolution on local forest institutional changes. It has been conducted in Dak Lak province, located in the central highland of Vietnam. The study has been started since 2001 consisting 18 months of field data collection plus 18 months of analysis at Humboldt University.

**Keywords:** Devolution, forest, institutional change, Vietnam

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## Community Forestry in Northeast Thailand — An Approach for Sustainable Forest Use?

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In the early 1990s Thailand launched an ambiguous, widely criticised ‘Forest Program’ to protect its heavily degraded forests in which community forestry should be given a more prominent role. Community based approaches have shown their potential to manage forest resources in a sustainable way particularly where the resource degradation is rooted in the loss of enforceable management and use rights of local communities.

However as these community forestry schemes are placed in a triangle with state dominated, mainly top down approaches on one side and forest management schemes only regulated by market mechanism on the other, there is a strong need to overcome continuous pressure from both ends and permanent adjustments are necessary prerequisites to secure functioning community forest schemes.

With this background the paper analyses whether and how community forest approaches are able to overcome restrictions and contribute to the sustainable management of forest resources as well as reducing rural poverty. The research assesses general aspects of forest- people-relationship and the evolution of the community forest movement in Northeast Thailand. It evaluates in a case study the socio-economic importance of community forestry for rural households /villages.

Even though many cases suggest that there are local approaches in communal resource management looking back on a long history, their sustainability and applicability to changing socio-economic and political environments seems to be limited. The adjustment processes are exacerbated by the lack of enforceable formal rights of local communities to forests and forest products. The paper presents evidence that villages with community forests have developed a wide array of income-generating activities with a good balance between forest dependent and non-forest dependent activities. The use of forest products tends to be on the decline for households with access to secure and attractive non-farming income alternatives. A successful community forest management concept needs to provide for alternative employment opportunities and an economically attractive use of community forests for local communities. Preconditions are secure communal and private land use rights as well as regulations that allow for sustainable community forest management measures including moderate logging activities.

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**Keywords:** Communal resource management, community forestry, local responses, Thailand

## **Forest Devolution in Dak Lak, Vietnam — Processes of Differentiation in Forest Benefits among Local Households**

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In Vietnam, the upland and the low land regions have long been characterised by not only the differences in topographic conditions but also the differences in state policies. Over the last decade, while the agricultural land tenure has been among the major concerns of the lowlands, forest land tenure has been in the centre of interest for upland region policy. Among various efforts being taken with regard to the upland development, forest devolution policy has been tried in different places. While how far forest devolution policy has contributed to the development process in the uplands is yet to be answered, an important question that arises is what effects the implementation of forest devolution policy has on the differentiation in the upland rural area. Put it differently, it is important to know if the implementation of this policy at the local level contributed to widen the (existing) differentiation among local households or whether it reduced this differentiation.

This paper subjects this question to empirical research on the effects of forest devolution in the Central Highlands of Vietnam. In this paper, I discuss the major processes through which forest endowments and entitlements were differentiated or undifferentiated among local households. I also discuss the connection between differentiation in benefits from forest devolution among local households and the process of agrarian change. Findings from the paper are interesting. Empirical analysis shows that there existed processes that widened the differentiation in benefits from forest devolution at the same time with those that alleviated this differentiation. More interestingly, it is shown that the processes of benefit differentiation were not fixed but changing through different stages of time, instead. Furthermore, the paper shows that political power had various effects on the household's derivation of benefits from devolved forest. Forest devolution programme accentuated an interesting relationship between the state and households with political power through which both parties tried to pursue their long term goals.

**Keywords:** Differentiation, forest devolution, forest endowments, forest entitlements, Vietnam

## The Arena of Conflict Management Between Farmers and Herders in the Southwest of Burkina Faso — Obstacles for Empowerment

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In today's political realities there is a strong tendency for bargaining and negotiation policies. An inclusion of organisations and organised interests has taken place not only in western political decision making processes but also in more traditional societies. In times of political, economic and social transformation in West Africa conflicts of interests over natural resources, particularly between 'farmers' and 'herders', are common problems and of growing concern. Instruments like decentralisation and land tenure reform may empower actors and actor groups to support successful conflict management. But the question for 'who empowers whom and how' arises immediately. Therefore, an analysis of frame conditions, institutional arrangements and actors' roles and networks is necessary.

Between 2001 and 2003 a study on conflict management was undertaken in the Southwest of Burkina Faso. 124 households and the local authorities in six villages participated in semi-structured interviews and group discussions. Also representatives of the regional and national meso- and macro level were interviewed to identify their involvement in and perception of conflict management.

Beside the 'farmers' and 'herders' different actors in the arena of conflict management could be identified: local authorities (mediators); administration (local /regional as mediator, national as frame condition donor); 'politicians', influencing decision making processes at local as well as at national level; development projects and NGOs, supporting negotiation processes. Local-level solutions for management problems are preferred and capacity building due to its impact in sustainable and equitable land use planning and resource management has been seen as a prerequisite. Although the actor groups pointed out their own potentials to serve e.g. as catalyst for negotiation processes, the ties between them, if they exist, are dominated by information gaps, hierarchical influence and distrust. Numerous obstacles for the fulfilment of theirs or other's roles were listed: actor's lack of means and abilities, state's unwillingness to share power with the civil society, and the feared abuse of power by powerful individuals for the realisation of their personal stakes.

It seems that empowerment has to be seen not only as a question of who, whom and how, but also as a question of control of power relations.

**Keywords:** Arena, Burkina Faso, conflicts, conflict management, decentralisation, empowerment

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## Governing Agrobiodiversity — Institutional and Gender Analysis of Transition in South India

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Agrobiodiversity is a common resource, on which our future global food security rest, while simultaneously representing the means of survival for many farmers at present. Women have been identified as the key-persons regarding knowledge and management skills. Threatened by increasing privatisation and market integration, men and women farmers risk the loss of diversity in favour for poverty reducing income opportunities. This dilemma is faced differently by men and women, because institutions and governance structures, rules and regulations confront actors according to gender. Property rights, value systems, informal ways of organising create diverse opportunities and challenges. Considering women's responsibilities for the daily management, provision and preparation of divers plants at stake, the need arises to integrate gender and institutional analysis.

This contribution focuses on the recent transition taking place in the institutional environment with special emphasis on the gender dimension. The Indian Government has introduced the "Protection of Plant Varieties and Farmers' Rights Act" in 2001 and the "Biodiversity Act" in 2002, setting a formal framework for the management of the resource biodiversity. Central to this paper is the question how women concerns are reflected in theory as well as in practice and what kind of opportunities arise form this institutional evolution and its policies. It draws on empirical evidence from Kerala, South India, a hot spot of biological diversity. The identification of relevant actors and formal as well as informal institutions in the eco- and farming-system of paddy cultivation, sets the ground for a gender specific analysis of the governance structure determining the decisions over use and conservation of agricultural biodiversity. The paper introduces the natural resources at stake and the social and cultural organisation of biodiversity management in Southern India. Since the category gender is central to the question of equitable governance structures, its' integration into the framework for institutional analysis is made explicit. The focus is on the study of property rights, influencing the access and control of resources and power in decision making processes. The emerging governance structure reveals conflicts and co-operations, missing links and innovations. Results consider the theory of co-evolution of social and natural systems.

**Keywords:** Agrobiodiversity, gender, India, institutions

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## **Determinants of Efficiency of Community-based Institutions for the Management of Small-scale Irrigation Systems in Northern Ghana**

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In many countries, institutional weaknesses and performance inefficiencies of public irrigation agencies as well as poor maintenance and ineffective control over irrigation practices have resulted in the collapse of irrigation systems. Moreover, deteriorating government fiscal positions in the face of mounting operation and maintenance costs of the irrigation agencies have stimulated the adoption of programs to devolve responsibility of irrigation management to users groups in many countries. Although the actual outcomes of the devolution programs have been mixed, theoretical advantages and growing promotion of community-based irrigation management suggest that these institutions may be successful not only in efficient management but also equitable distribution of benefits from the schemes. Successful devolution programs in some regions of the world have motivated a lot of donor support for development of small-scale irrigation schemes under community management in Northern Ghana. At the same time, farmer participation in the management of existing larger schemes has been promoted. Evidently, some communities are managing their schemes better than others. What remains unclear is the degree to which these institutions promote efficiency, and the sources of inefficiency associated with community-based management of the common pool resources. The paper examines this issue by developing a theoretical framework for the empirical measurement of management efficiency and applying it to data collected in 50 communities managing small-scale dams in northern Ghana. We then use econometric analysis to analyse the determinants of inter-community variations in efficiency. The results show that membership size, benefits from the scheme, exit opportunities, number of villages sharing in the use of the schemes as well as prior organisational experiences of communities impact on the efficiency of the schemes. Simple flexible rules established by members, extension education and training programs on group dynamics and cooperative management as well as improved legal backing for local institutions could improve upon the efficiency of the community-based irrigation management institutions.

**Keywords:** Devolution, efficiency, institutions, Northern Ghana, small-scale irrigation management

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## **Beyond the Poverty Alleviation Programmes — Towards a New Framework for Managing Natural Resources in Nigeria**

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Based on experience from a EU project for rehabilitation of a grazing reserve in Nigeria and the failure of the Nigerian state to establish appropriate programmes for reducing poverty that is prevalent in her rural areas, this paper offers a model for co-management of natural resources that affect the livelihoods of the rural poor in the country. Co-management is a pluralist approach to managing natural resources, incorporating a variety of partners in a variety of roles, generally to the end goals of environmental conservation, sustainable use of natural resources and the equitable sharing of resource-related benefits and responsibilities. This paper assumes that rural poverty could be reduced in Nigeria through co-management of natural resources on which most rural poor depend for livelihood. The paper first reviews the causes, distribution and level of poverty in Nigeria and explains why government programs have not succeeded in reducing poverty in the country particularly in the rural areas. The paper also discusses the vicious cycle that exists between poverty, natural resource degradation and conflicts as a way of justifying why appropriate management of natural resources could prevent destructive conflicts and consequently, reduce rural poverty. The paper then suggests **1)** mechanisms for involving all major stakeholders in establishing co-management institutions, **2)** roles the stakeholders should play, **3)** ways for strengthening and sustaining the co-management institutions if established, and **4)** the need for incorporating participatory monitoring and evaluation in the co-management institutions. The paper finally suggests that co-management should be tried as pilot projects before it is applied nation-wide.

**Keywords:** Co-management, government, local communities, natural resources, poverty reduction

## **Development of Adequate and Reliable Certification Schemes Concerning the Import and Use of Tropical Timber for the Free and Hanseatic City of Hamburg**

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The achievement of sustainable forest management (SFM) is a process and the forest management certification is an effective tool to assess progress towards implementation of SFM. The Free and Hanseatic City of Hamburg (HH) is currently implementing a policy to restrict the import and public use of tropical timber to material that has been certified under internationally accepted certification schemes. A first step towards implementation of this policy is the evaluation of existing certifications schemes as well as the definition the specific requirements of HH concerning SFM. One of the schemes assessed is the system operated by the Malaysian Timber Certification Council (MTCC). MTCC is an independent organisation established to develop and operate a voluntary national certification scheme in Malaysia. The current MTCC scheme is based on the 1998 ITTO Criteria and Indicators for SFM. MTCC started operation in October 2001 using a phase approach. In October 2002 the standard has been revised and the present draft corresponds to the Forest Stewardship Council (FSC) principles.

Based on discussions between MTCC and HH in 2003 a joint project is launched in 2004. The main objective is to provide scientific support for the refinement of the new standards — particularly in field tests — to ensure its practical application and to close identified gaps, especially on the Indicator/Verifier levels. Within a time frame of two years, German and Malaysian forestry and certification specialists cooperate with relevant organisations (environmental, social) in Malaysia. The project is jointly funded by MTCC, HH, German Technical Cooperation (GTZ), and the German Timber Federation (GHD).

After the final elaboration of the new standards and implementation in the certification scheme the HH will accept certificates issued by certifiers accredited by MTCC.

**Keywords:** Development of certification scheme, Free and Hanseatic City of Hamburg, import and use of tropical timber, Malaysian Timber Certification Council, sustainable forest management

## How Incentives Matter — A Conceptual Framework for Natural Resource Governance in German Development Co-operation

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Many problems of unsustainable management of natural resources all over the world are due to a limited number of basic governance shortcomings such as open access, lack of property rights definitions or insufficient enforcement of existing rules. Often however, researchers and to an even greater extent practitioners in development cooperation focus on one single natural resource and ignore the analogy of problems in related fields. As a consequence, many insights gained in one field, e.g. with regard to irrigation, are not transferred to similar issues and thus remain idle. Chances to learn from other sectors are passed up.

In this paper, a conceptual framework for analysing the governance problems behind unsustainable management of natural resources is proposed. The framework takes an institutional economic perspective, and is applicable to all kinds of natural resources, regardless of their physical quality. The core of the framework draws on the Institutional Analysis and Design (IAD). Consequently, it focuses on an identification of incentives that motivate the way environmental goods and services are used. In addition, it provides an elaborated instrument to analyse and categorise related governance measures. Overarching objectives of development cooperation such as poverty alleviation are also included. The framework serves as a common theoretical background on which to analyse management problems, their causes, and possible interventions. Thus, a basis is provided to compare actual case studies and to draw conclusions on explicit and implicit goals of development policy and its shortcomings.

The empirical part of the paper illustrates the application of the framework and presents a survey of case studies on resource management in developing countries. The results of this survey include (i) a quantification of governance measures applied, (ii) data on proportions of effective and ineffective attempts to modify institutional arrangements, and (iii) an analysis of interdependencies between the economic characteristics of the good, institutions, and successful development cooperation. For the first time, it gives an overview of the actual approaches applied in German development cooperation with regard to natural resource management.

**Keywords:** Development co-operation, governance, incentives, institutions, natural resource management, sustainability

## **Exercising Community Property Rights in Water Resources Management**

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In the Philippines, water resources are state property. However, private appropriation of the resource is granted through the water permit. Various tenurial instruments with regard to water are also recognised through different natural laws. In essence, therefore, there is a myriad of property arrangements available as options for management of water resources. This is both beneficial as well as limiting given the complex nature of water resources.

The current centralised management of water resources and development has led to the overutilisation of the resource in critical areas. This is attributed to the lack of capacity of the state to control and monitor down to the local level, which has encouraged the unsustainable practice of water use. Also use right alone is not enough incentive for users to manage and protect the resource. Therefore, the realities of management of common pool resources where a central body can hardly enforce exclusion and control, or where benefits and entitlements are concentrated/monopolised by a few, can be best addressed by a community property regime.

The best option given the above is for the community, as collective co-owners of water resources, to have control over the utilisation of the resource while taking responsibility for its sustainable management and development. The management and authoritative scheme for such property regime cannot be dictated but rather, should be allowed to evolve based on the need of the community and the nature of the water resource to be managed. Within a specific watershed, this could take the form of different co-management bodies (groundwater management council, lake development authority, river agency, etc.) operating under the framework of the integrated management of the larger watershed or river basin resources.

The shifting of power from the state to the community has several requirements foremost of which is community involvement in decision-making. This will only happen with recognition from the different stakeholders including the state that the community can be effective managers of the resource. It is the essence of empowerment, where the community can be effective partners of development as well as beneficiaries of their own efforts.

**Keywords:** Common property regime, common property rights, water management

## Supporting Institutional Change in the Highlands of Madagascar

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Service providers are considered to be important actors in rural development as they are supposed to facilitate the access to goods, services and markets for the rural population. However, the performance of many public services is limited and very often, alternatives to public services do not exist. Rural development projects often aim at establishing or supporting rural service providers who are expected to carry on services after the project's phasing out. However, impact evaluations of these organisations' performance reveal a declining performance after the running out of projects' financing.

Since explanations for this development might be discovered during a project's term, the objective of the study was to identify supporting and impeding factors for the design and the performance of a rural service provider in the Highlands of Madagascar. The organisation's performance has been analysed on the basis of the following elements: demand orientation, flexibility and external relationships, organisational structure, staff potential and financial resources. Furthermore, in a three-years-process, the project's influence on designing and change of the service provider has been examined.

The results illustrate the influence of organisational structures on the service provider's strengths in demand orientation and the increase in flexible reactions to the population needs. Nevertheless, a low staff potential and lacking external relationships obstruct increase in performance and render the service provider dependent on actual and future external support.

Moreover the study revealed that founding and supporting the service provider has been tackled too late by the project and a lacking consolidation of the supported organisation in the institutional context. The different cultural rationalities of European and Malagasy partners as well as the staff's potential to independently manage the organisation were not adequately taken into account.

Consequently, finding adequate solutions for sustainable institutional arrangements is a complex and long-term process. Therefore, definite options for handing over responsibility must be developed in a participatory manner and a sound and sustainable financing concept must be developed with all stakeholders.

**Keywords:** Institutional transformation, NGO, service provider

## **Linking Research and Development in Southwestern Burkina Faso**

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One of the great challenges of our times is to effectively link tropical research in the fields of social, economic and natural sciences with the actual development work that is under way at grass root level. The big institutions, both from the research and the development side are largely fixed into long-term agendas, such as clearly defined programs and projects, that allow only little mutual influence or impact, certainly not at short notice. But if development is supposed to be researched for and to be researched at efficiently, research results have to be applied quicker and for that, knowledge has to be transferred faster. This is especially difficult with PhD and MSc theses. These works are not transformed into development action immediately, but only after long periods of data analyses and writing up, followed by the relevant publications that make the information accessible to the greater public, which might then decide to pick it up. Ideally, good research results should be transformed into broader scale testing much earlier. To achieve this, the Center for Development Research (ZEF) at the University of Bonn has signed an agreement with the Dreyer Foundation in Munich. The goal of the Dreyer Foundation is professionally based development work in the southwest of Burkina Faso that includes agricultural and environmental development, training of academics and non academics as well as support of children in need (orphans, better schooling). In view of that the Dreyer Foundation is constructing a research and training centre near the town of Dano in Burkina Faso to be utilised by interdisciplinary activities connected with the rural development of the region and beyond. The common administration of both development and research activities, i.e. by sharing technical staff and other resources as well as more flexible funds will provide the grounds for quick transformation of promising research results into practice. On the other hand the development activities of the Dreyer Foundation will greatly help to identify the most urging research questions. Currently three projects of ZEF or with ZEF participation are accommodated at Dano: GLOWA-Volta, BIOTA West Africa, Virtual Institute.

**Keywords:** Culture, hydrology, irrigation, research and development, small dams, socio-economy, sustainability, West Africa

## Complementary Management of Wildlife and Livestock in West Africa — Utopia or Development Perspective?

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Income from game viewing and trophy hunting is increasing in eastern and southern areas, game populations are increasing in some countries and programmes like CAMPFIRE have shown the potentials for local communities to benefit from these trends and National Parks. In West Africa, by contrast, there has been a sharp decline in wildlife populations and nature conservation and rural development are still antagonists. In 1999 GTZ started a special project on complementary management of wildlife and livestock in West Africa with the aim of indicating potentials of improving income in rural areas from wildlife management. A workshop in Niamey explored possibilities of enhancing complementarity between livestock and wildlife management and a guidebook has been prepared.

Traditionally wildlife was well managed, with some species (e.g. ostriches in northern Niger) even moving with livestock herds, or planned extraction e.g. of hippopotami in Mali: However state ownership undermined traditional rules for wildlife management with no effective institution replacing them. Indiscriminate hunting by state officials or princes from Gulf States contributes more to the destruction of wildlife than local hunting, which is often criminalised.

Nevertheless small game, such duikers, grass-cutters or giant snails contribute substantially to local meat supply, yet sustainability is endangered because of high hunting pressure. Some species such as grass-cutters or giant rats are now partly domesticated, giving rural people additional income. The inadequacies of the legal framework in West Africa have been recognised and reforms of the Code pastorale and other laws are under way granting local people more rights to wildlife. Stakeholder platform have been created to include sustainable use of wildlife as part of natural resource management. Initiatives such as the “Projet des girafes à Koure, Niger” show the potentials of such an approach. Here — outside a national park” — the last giraffes in West Africa are protected. People benefit from giraffes from giraffe tours, sales of curios, get external support for vegetable marketing as compensation for possible crop losses through wildlife, but local people also take increasingly pride in their giraffes, which have over the last five years considerably increased in numbers.

**Keywords:** Code pastorale, livestock, traditional rules, wildlife

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## **Sustainable Use of Animal Genetic Resources under Unfavourable Production Conditions: an Institutional Perspective Within a Natural Resource Management Framework**

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Animal genetic resources comprise all livestock species, breeds and populations domesticated for human purposes and their wild or semi-domesticated relatives. Animal genetic resources are rarely addressed in research for natural resource management. This, however, does not render them less important. On the contrary, animal genetic diversity is eroding at an alarming rate, while its long neglected genetic potential is presently perceived as invaluable for future developments.

Within the majority of rural smallholder production systems livestock constitute a valuable asset and a vital livelihood component. Exploiting the diversity within and between animal breeds, in this regard, contributes to the ability of these production systems to undergo changes and to provide for present and future food-security and other important livestock functions. Strategies for the conservation and sustainable use of animal genetic resources recognise that constant breed improvement intervention is necessary in order to maintain local adapted breeds as economically profitable and socially benefiting parts of production systems.

This paper introduces a conceptual frame for community-based management of animal genetic resources in which the yet never explicitly considered local level institutional development emerges as a key element for achieving sustainability in the utilisation of indigenous livestock breeds.

The emphasis on institutional development to respond newly arising demands for collective action in community-based animal genetic resource management is rooted in three subject areas. It is deduced from animal genetic theory. It is reflected in the operational difficulties experienced in breed improvement initiatives, where the concomitant of local institutions, namely, local participation is remaining a primary shortcoming. It is furthermore demonstrated from evidence in other natural resource management areas that local institutions, initially effective for decision-making and for resolving resource management conflicts, evolve into increasingly more complex structures with the capacity to tackle additional development needs.

Results of a case study conducted in West-Africa, analysing the institutional environment of a traditional cattle breeding system further underpin the need of the above delineated concept of explicitly including an institutional perspective into livestock

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development approaches. In this example, causes and effects of local institutional weaknesses became apparent. Local capacities and related options for participatory interventions were identified.

**Keywords:** Animal breeding, animal genetic resources, institutional development, natural resource management

## **Sustainable Financing of Natural Resource Management — An Example from the Brazilian Amazon and Implications for the German Bilateral Development Assistance**

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Protected areas are an important means for the sustainable management of natural resources, as they prevent ecosystems from being transformed. The management of protected areas causes recurrent costs irrespective of whether they are managed by park administrations or the communities living inside them. Due to the nature of protected areas, recurrent costs occur for very long periods of time. On a global level, insecurity of resources to finance recurrent costs threatens the sustainability of protected areas. Financial resources to cover the recurrent costs of protected areas can be administered by different types of institutions. Commonly, those resources are administered by the state. An alternative type of institution is an environmental fund, which is a specialised institution administering and disbursing financial resources for environment policy measures. This paper compares these types of institutions using the following two criteria: security of financing and community participation. A theoretical analysis of these types of institutions suggests that environmental funds are more suitable for administering recurrent costs of protected areas. Given budgetary constraints of many governments in developing countries, earmarking financial resources for environmental purposes is an advantage of environmental funds. Furthermore many environmental funds have institutionalised participatory structures enabling local communities living in or nearby protected areas to influence decisions on the use of these financial resources. Conversely, in many parts of the world government agencies are characterised by a top-down approach in decision making. As participation is highly important in order to identify appropriate solutions, environmental funds are preferable to government agencies. Protected areas in Brazil can be divided into two categories: protected areas administered by park administrations and protected areas managed by local communities. In areas of high deforestation in the Brazilian Amazon only the latter type of protected area effectively preserves the rain forest. This underlines the importance of establishing an institution with participatory structures to administer the funds used to finance protected areas in the Brazilian Amazon. Currently, budgetary regulations for bilateral development assistance in Germany do not allow using development assistance resources to finance environmental funds. Given the findings above, these regulations should be amended.

**Keywords:** Brazil, environmental funds, protected areas, sustainable financing

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## The Hidden Cost of Communal Action and How to Make It More Affordable

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Institutional aspects have often been neglected in technically-driven projects. A study in south-west Burkina Faso investigated institutional factors affecting the uptake of animal disease-control innovations. Tsetse-transmitted trypanosomosis is the most serious disease of cattle in sub-Saharan Africa, threatening the livelihoods of millions of farmers in the poorest continent of the world. Technologies for tsetse control, (using baits or treated cattle or cloth), have proven effective, cheap and simple to implement at village level; however adoption has been disappointing. We reviewed 9 participatory tsetse control projects in Burkina Faso, and found that vector control was never spontaneously adopted, and never continued with after the departure of the initiating project. We used participative tools and processes to investigate the institutional factors influencing this failure of uptake. This involved a proof-of-concept vector control project using a high-level participatory approach. After the hand over of activities to the communities, a participatory evaluation was carried out with the farmers. It found that although the price of vector control inputs were low, the transaction costs of setting up and maintaining the community-level organisations needed to deliver long-term control were high. The process studies and participatory tools used to assess these transaction costs are described. The farmer-perceived costs of control were compared with conventionally measured costs using market prices; it was seen that omitting transaction costs resulted in a four-fold underestimation of the full opportunity costs of implementing community vector control. Social capital was estimated by various proxies including involvement in community groups and patterns of social interaction. Social capital was found to lower the transaction costs of control, but not sufficiently to render tsetse control attractive in the communities studied. Other factors which have been shown to reduce the transaction costs of communal action are discussed and conclusions drawn on how to make livestock-disease control interventions requiring communal action more attractive to poor farmers.

**Keywords:** Burkina Faso, communal action, participation, social capital, transaction costs, tsetse control



# Subsession 1d: Self Help Organisations and Rural Enterprise Development

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## Community Action to Protect Fishery Resources in Nha Phu Lagoon, Vietnam

HARRY STREHLOW

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Rural communities around Nha Phu Lagoon depend on coastal fishery resources for their livelihoods. The prevailing problem is that unorganised Vietnamese fishermen are watching helplessness at the vast degradation of their natural resources in which they have a substantial share. The over-exploitation of marine resources is a common and recognised problem and fishery resources protection and management is under development. However, so far government measurements are not yet sufficient to carry out the assigned tasks.

For a period of six months participatory action research following an Integrated Natural Resource Management approach was carried out visiting 12 fishing villages around Nha Phu Lagoon. Electric fishing is still very common in Nha Phu Lagoon and was identified as one major factor in the destruction of coastal fishery resources and social structures. Electric fishing gear stuns small fish and shrimp but kills larvae and eggs of aquatic species floating in the water body. Electric fishing violates Article 6 according to Resolution No. 17/2003/QH11 of the National Fisheries Law. The main reasons fishermen engage in electric fishing is the low initial investment cost and that no specific knowledge is needed. In addition, electric fishing is less labour intensive and the income slightly higher than from traditional gill net fishing methods. Seven years ago electric fishing was introduced to the village of Ha Lien. Soon half of the fishermen were using this destructive fishing method. The following rapid reduction of fishery resources lead to conflicts that paralysed the entire community until a village meeting was arranged to raise awareness and persuade fishermen to ban electric fishing. The whole community agreed to ban electric fishing and in 2002 a local fishery resource protection group was established to control illegal electric fishing activities in the area. The local government authorised the self-formed group and 20 group members patrol and confiscate electric fishing equipment. The number of electric fishermen in the area has declined significantly. Today fishermen in Ha Lien are characterised by high awareness towards the degraded state of their natural resources and strong communal ties have formed between households.

**Keywords:** CBRM, Coastal fisheries, community action, community management, electric fishing, fishery resources protection, self organisation, Vietnam

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## **Micro Financing Within Joint Forest Management Committees for the Empowerment of Women Self Help Groups in India — A Case Study from Betul District, Madhya Pradesh**

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Micro financing has been proved to be an effective measure to provide financial access to the poor people. In India, women Self Help Groups (SHGs) have served as vehicles for providing financial access to the rural women leading to their empowerment. But there is a huge unmet gap in demand and supply of micro finance to the rural women, which requires a number of Micro financing Institutions to be developed at local level. The success of Joint Forest Management, in the state of Madhya Pradesh, has created such local level institutions, known as Joint Forest Management Committees (JFMCs). The accrued funds in their accounts they receive mainly in-lieu of the protection of forest areas allotted to them. Within these villages, some women have organised themselves into small groups and they are saving small amounts that is rotated within their respective members for supporting their urgent family needs. However, these amounts do not satisfy the real needs.

Functioning and impacts of women SHGs in villages of the JFMCs have been studied testing the actual system. The study reveals the importance of the facilitator for the development of SHGs. Training is found to be crucial input for the facilitator as well as for the SHG members. The JFMCs and SHGs are performing lending activities, to their members, but they do so independently. The financial linkage between the two is missing. Therefore, a JFMC-SHG linkage model has been derived for providing financial access to the SHGs. However, an integrated approach of various actors is required to make this model operative.

**Keywords:** India, revolving funds, women self help groups



## **Income Generation through Village-based Bamboo Development**

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On the island of Negros, Philippines, a bamboo development project creates new livelihood opportunities for smallholder farmers and their communities. Traditionally, bamboo has been used in the Philippines for countless domestic purposes, such as farm utensils, fishing gear and housing material. More than 50 species of bamboo are accounted for in the Philippines. It naturally occurs in the remaining forests but is also present in lowland and upland agricultural environments. It can be found on riverbanks, along boundaries and in small groves. Despite its cultural importance and its availability, bamboo has never gained commercial importance in the local economy. The project presented makes use of this indigenous plant. A neglected resource has been turned into a value added product which generates additional income. Main actor is a local non-profit organisation, the Buglas Bamboo Institute, which gives focus on bamboo development in rural communities. This sector approach includes different strategies. Extension work plays a major role; farming communities are organised into self-reliant village organisations. These groups are considered partner organisations rather than beneficiaries. Technical training capacitates farmers to produce quality bamboo poles; this includes bamboo stand management, post harvest treatment, and processing into semi-finished bamboo products. All activities are carried out in individual farms or village bamboo centres. Aside from extension work, a research unit of the institute develops appropriate bamboo technologies. Most bamboo products from the villages are bought from a subsidiary company of the institute which is manufacturing high quality bamboo products, like furniture, construction components and novelty items. A unique scheme of support, income generation and profit has gradually evolved between the three parties involved. Terms of trade follow consistent principles of fairness, transparency and predictability. This empowers farmers and their organisations and creates rural enterprises. Income generation contributes to a savings scheme which helps to instigate further livelihood activities. The various steps of building up self help organisations and creating bamboo based business opportunities are being discussed; furthermore, the relationship between the development organisation as change agent, the grass root organisations and the trader/buyer are analysed. Lessons learnt will be presented.

**Keywords:** Alternative livelihood, bamboo, self help organisations

## Community-based Organisations as Partners in Poverty Alleviation: Lessons Learnt and Good Practice Examples from Yemen

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The increasing importance and recognition of Community-Based Organisations (CBOs) in poverty reduction and decentralisation contexts is self-evident. However major challenges remain related to their capacities to assume key responsibilities at local level and their vertical integration into existing institutional settings. This paper discusses preconditions, good practice and operational lessons learned about organisational capacity development and empowerment processes analysing the set-up and the institutional/organisational aspects of CBOs initiated and/or strengthened with the support of the Community-based Regional Development Program (CBRDP) in five distinct socioeconomic and ecological areas of Yemen. It assesses comparative advantages and potentials of local institutions and CBOs in decentralised rural development.

The study collected and used primary and secondary data applying different Participatory Learning and Actions (PLA) methods and tools. Study findings show that an area-based flexible process approach was suitable to create local confidence in CBO operations and to respond to the dynamic needs of local communities. Moreover, investing simultaneous in institutional and human capacity and productive asset development it proved indispensable for both success and sustainability. At the CBOs levels, the local socio-cultural, institutional and political settings revealed significant in shaping the organisational maturity and mode of interactions within the CBO as well as between the CBO and their environment. Successful CBOs were often those which proved prosperous in **(a)** practising —internally— good governance based on clearly defined leadership/advisory functions between traditional leaders and elected representatives of the poor, **(b)** prioritisation-based selection between productive investment and social initiatives, **(c)** linking poor to middle income groups using innovative ways building on their indigenous norms and practices and **(d)** establishing operational horizontal and vertical linkages with other institutions. A legal framework which supports the combination of social self-help initiatives and economic activities appeared as an essential precondition for successful the CBOs operations and sustainability. CBOs showed good potentials to coordinate local poverty reduction initiatives and to contribute, through coalitions with others, to pro-poor policies at the macro-level

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**Keywords:** Community-based organisations, group-based enterprise development, integrated local development planning

## **Incomes and Rural Differentiation — An Empirical Study in the Pelarco and San Rafael Community, VII Region, Chile**

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This investigation was carried out in Pelarco and San Rafael community, VII Region of Chile, between 1999 and 2000 years. These two communities from the central Chile have a high level of agricultural activities and rural population. The target population included small farmers associated to the “Centro de Gestion Empresarial Pelarco”, which is rural self-help organisations to the small farmers. This mainly transfers soft technology innovations to its peasant target group.

Data were collected from both secondary and primary sources. The secondary sources included published and unpublished information about the study area. The primary data were collected from a sample of 43 peasants, (on which the study was largely based). The instrument applied was a structured questionnaire.

The central hypothesis sought to show that the differences of incomes of the small farmers could be explained mainly through indicators related to differences in the production factors endowment, socio-cultural and psycho-social elements of the farmers.

The results emphasise the high correlation among the indicators used to present the level of income of the small farmers. The Total Gross Income of the farmers presented an average of 11.944.442 Chilean pesos (807.3 UF). The variables that most contributed to explain the difference of the income are; the capital, the land, the production structure orientation, the family labour availability, the level of training, the innovative conduct, the management and the enterprise capacity. Through the multiple regression analysis, it was found a  $R^2 = 0.45$  between the depending variable “Gross Income” and seven explanatory variables considered in this study.

**Keywords:** Income, peasants, small farmers

## **The Indigenous Village Organisations in North Sumatra, Indonesia, Start the Self-Help from the Social Purposes**

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The performance of any kind organisations in the rural area however is influence by its social character, economical and cultural environment of the community. The potential of the self helps organisation in combating the poverty has known by development practitioners, but it approaches for establishing the organisations is frequently counterproductive for the self-reliant of organisations. In other side there are custom organisations in the rural area. The local government tend to overseen the potential of this organisations in the village development planning. The objective of this study is to analyse the potentials of the indigenous village organisations to network with the village government in order to pursue the village development. This qualitative study observed the indigenous village organisations (Mutual-Helps Organisation and Kin Organisation) in North Sumatera where the community are strongly hold the culture of Batak.

The social structure of Batak's is tightened by the kin system called Dalihan Na Tolu or translated as three groups in one system. These two village organisations are quite important for villagers' livelihood. They have also a broad membership in the sub-villages. Both organisations have the social purpose related to the custom as the main objective. However as intermediate objective they do also other activities such as saving and credit activities and maintaining the sub-village infrastructure. These organisations have a structure and rules and they held the members meeting yearly as a form of accountability of the leader to the members. The social capital has made the work of this organisation efficient. The leadership follows the patronage relation; indeed the capability of the leader has the important role to widen the organisational purpose and to build the network with the village government. However the network between the local organisations with the village government is hardly influence by the perception of civil society in the community. In this context, the initiatives of the regional government and NGOs are needed to build the closure among the village organisations in order to pursue the village development.

**Keywords:** Networking, rural development, rural organisation, village governance

## **The Impact of Social and Human Capital on Economic Welfare — The Case of Polish Farmers**

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All over the world small scale farmers are characterized, among others, by a lack of management skills, market information and capital, and by rather low levels of income. One option to overcome this situation might be the substitution of limited production factors with one which is more readily available. The existence of such a factor is being analysed under the concept of social capital. It reflects the ability of the people to co-operate with each other. It is revealed in the existence of formal organisations and informal networks of the agricultural producers to pursue their own interests and to improve their economic situation. This issue is of particular relevance not only to farmers in developing countries, but also to their colleagues in transition economies as such types of organisations did not exist under the socialist regime and had to be built up from scratch since 1990.

As a first analytical step, this hypothesis is tested in making use of data of a Polish farm survey executed by IAMO in 2000. Six independent factors could be extracted from a set of 15 variables by factor analysis, i.e. life and job experience, participation in further training, physical capital, production structure and used labour, informal exchange of experiences, and social capital and education. The results show that social capital depends on education and can be identified as an influencing factor. Four of the six factors represent personal characteristics of farm owners that can be seen as indicators for managerial skills. These are life and job experience, participation in further training, informal exchange of experiences, and social capital and education. It has to be noted that these factors exist independently from each other.

In addition, cluster analysis and discriminatory analysis were used to identify groups of homogenous farms. Seven groups can be distinguished representing Polish farms fairly well. In comparing the groups it is shown that the effects of social and human capital on economic welfare differ widely. It can be concluded that, on the one hand, farmers managing large farms accumulate social capital for improving farm income. On average, they are younger and better educated. But, on the other hand, there is a group of farmers operating medium farms with a high level of social and human capital who earn a higher percentage of their family income from off-farm sources. These farmers may use their social and human capital to exploit alternative sources of income. Finally, there is a group of farmers owning small farms who do not invest in social capital with respect to agricultural production at all because their major source of income is off-farm.

**Keywords:** Farm income, human capital, Poland, Small scale farming, social capital

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## **Smallholders Access to Credit and its Impact on the Adoption of Agricultural Technology: Evidence and Lesson from Agriculture Practices in the Vicinity of Lore Lindu National Park, Central Sulawesi, Indonesia**

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A number of recent studies have assessed the impact of the access to credit on household income and consumption. However, there are few studies that analyse the impact of credit access on agricultural production and technology adoption and that control for the endogeneity of credit access and related borrowing. The evidence of these studies is mixed, and a number of methodological issues remain.

In Central Sulawesi, Indonesia, a number of technological and cropping changes have taken place the past 20 years. While we find that in most of our 12 sample villages HYV rice varieties and hand tractors have been introduced, there is great household-level variation in the adoption of these and other technologies. For example, the use of fertiliser — apart from irrigated rice is relatively low when compared to more input-intensive systems found in Java. Formal credit is mainly provided through two main sources: the village banks of BRI, a state-owned bank, and the government-run agricultural credit programme KUT.

Many studies indicate that informal credit is mainly used for consumption purposes. In the case of the rural areas in Central Sulawesi Province, 51 percent of the households have access to credit, with not more than 15 percent financed by formal loans and the rest from informal sources. In general, loans borrowed from both institutions are rarely used to finance agricultural activities. The poorest use the borrowed loans for food and consumption activities, accounting for 60 percent, while only 1 percent use than for agricultural activities. Respecting the less poor households, borrowed loans are used either for food and consumption or agricultural activities, 34 percent and 31 percent, respectively

This paper examines based on the evidence in the vicinity of the Lore Lindu National Park using socioeconomic households survey data that was collected in 2000 and 2001 through standardised, of formal questionnaires from 293 randomly selected households out of 12 villages in rural Central Sulawesi.

**Keywords:** Access to credit, Indonesia, technology adoption

## **External Consulting — An Irreplaceable Strategy for Optimising legitimisation, Fundraising, and Innovation of Private Organisations Involved in Environmental Policy**

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External consulting improves legitimisation of board decisions, fundraising, and innovation in private organisations involved in rural environment issues. External consultants are expected to be more effective than internal expert groups in these functions. We argue that the external consultants serve as a quite effective bridge between an organisation (e.g. environmental NGO, industry federation or landowner association) and its institutional, social and economic environment. Thus organisations are advised to complete the employing of permanent internal expert groups with flexible external consulting. The quantitative findings are based on a survey carried out in 2002–3. Theoretical assumptions of Management Sociology (regarding legitimisation) and Organisational Sociology (resource dependence theory regarding fundraising and innovation) are employed in order to explain the results. We also argue that fundraising and innovation mutually favour each other, while both of them favour legitimisation of internal decision-making in high-centralised organisations.

High-centralised is an organisation when it has many members, small board with long term of office, rarely calls general meeting of all the members, and when in this meeting only a few members participate. Fundraising has been operationalised as the number of alternative financing sources that an organisation may use (national governmental programs, international governmental programs, sponsorships, occasional donators, capital investments). Innovation has been here plainly defined as the number of new projects in which an organisation was involved in the last two years. An innovative organisation opens up various resources in its environment like new partnerships and contacts that lead to greater resonance in the social and/or institutional environment of the organisation, and new fundraising sources (economic environment). All these social, institutional and economic resources can in turn make the organisation more innovative and further improve the legitimisation of its internal decision-making even under conditions of high centralisation, as long as the members recognise the board as effective.

**Keywords:** Consulting, environment of the organisation, organisation, resources

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## **Rural Enterprises — The Key to Poverty Alleviation and Rainforest Conservation?**

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For a considerable time harvesting of non-timber forest products (NTFPs) has been seen as a sustainable income generating activity for the marginalised forest-dwelling population, helping them to overcome poverty. However, the gathering of NTFPs rarely generates enough revenue to sustain extractivist households. Particularly as harvesting often takes place only for a limited period of time each year, depending on the availability of the resources harvested. Hence, most forest-dwelling households engaging in the extraction of NTFPs also depend on other income generating activities for the rest of the year. Among these the most frequently chosen are agriculture and lumbering. With respect to forest conservation, both occupations have to be considered non-sustainable.

Accordingly, to earn a livelihood without increasing deforestation, marginalised forest dependent households need to develop other relatively profitable sustainable enterprises. Rural enterprises and cooperatives engaging in various forms of processing of the locally harvested NTFPs might be an answer to these problems, contributing to both poverty alleviation and sustainability. Such rural enterprises are often built on the traditional knowledge of the communities, from which new techniques and thus new products are being developed. Besides providing sustainable occupations to engage in, the new rural enterprises and their business activities also may contribute to the communities self esteem and thus to regional identity building and maintenance.

Communities-mainly from legal Amazonia-with rural enterprises engaging in the processing of NTFPs are being studied with respect to the enterprises' contribution to poverty alleviation and level of deforestation. By analysing hard factors like income, education, migration and forest loss as well as soft factors like contentedness, interest in and using of sustainable management practices and improvement of the local living-conditions, the ability of such rural enterprises to offer a solution to both poverty and deforestation is being evaluated.

**Keywords:** Deforestation, poverty alleviation, rural enterprises, sustainability



# Subsession 1e: Policy Options for Targeted Rural Poverty Reduction

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## **Emancipating African Women through Agricultural Technologies — The Case of Irrigation Technology in Northern Ghana**

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Poverty in sub-Saharan Africa is both rampant and widely spread. However, its distribution is skewed to the arid and semi-arid agro-ecologies, rural parts and to some of the socially disadvantaged groups, such as women. The Guinea-savannah agro-ecology of Ghana is a case in point where one can find an interface between the agro-ecological and social layers of poverty. The Upper East Region is one of the regions located in this agro-ecology in Ghana. In this region more than 95 % of the population, which are mainly rural based live under the poverty line. Erratic rainfall, poor soil quality and increasing population pressure among others contribute to the prevalence of poverty in the region. In addition, the social construction is biased against women by depriving them entitlement to resources such as land. Most proponents of gender equality advocate for policies and technologies which are designed to generate income to women usually in the form of small trade. However, in a social set up, where women are deprived of title to resources the contribution of such endeavours towards emancipation of women is marginal. Therefore, the challenge ahead of researchers and policy makers is to identify appropriate technologies and policies that can address poverty in its totality. In this paper we analyse the effect of irrigation technology, on overall household income, gender differentiated income and rural job creation. It was found out that irrigation technology being a labour intensive technology is able to create huge employment to the increasing population in general and to women in particular. However, the sustainable utilisation of its potential contribution depends on factors such as, the performance of input and output markets.

**Keywords:** Emancipation, gender, irrigation

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## **New Ways for Rural Finance — Livestock Insurance Schemes in Vietnam**

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Livelihood systems of poor rural households are often so fragile that a small misfortune can destabilize the households for years. Risk coping strategies include informal mutual aid agreements and/or formal micro-insurance schemes. In developing countries, insurance markets are usually underdeveloped. Nevertheless, if the development path is supported by strong structures and institutions, anonymous markets will over time replace informal insurance networks as they are more efficient. In Vietnam, livestock is an important household income source and has additional non-economic functions in the households. Rural financial institutes in Vietnam financed for a long time only a small array of agricultural investments, but frequently including livestock purchase. The absence of off-farm investment possibilities further promotes the investment into livestock production. Failure of an investment, especially when loan-funded, can leave a household in an extremely vulnerable position.

Livestock death is considered to be a main factor contributing to poverty. Farmers using credit to purchase livestock face two risks at once: **(1)** loosing the livestock due to disease and subsequently **(2)** failure of investment. Farmers would like to reduce the uncertainty. Nevertheless, a formal agricultural insurance market hardly exists in Vietnam and farm households have to rely mainly on informal mutual aid schemes of social networks to reduce their risks. The objective of this paper is to contribute to the discussion on the general feasibility of a livestock insurance scheme in Vietnam. In this context the supply of livestock insurance schemes is discussed. Qualitative data collection took place between 2001 and 2004. Four different types of insurance providers were selected for analyzing the supply side: **1.** Insurance tied to credit within a state owned company, **2.** Insurance tied to credit within a development project, **3.** A state owned insurance company, **4.** A private insurance company. By selection of these different insurance providers the variance of livestock insurances offered in Vietnam was covered. The main result is that offering sustainable livestock insurance is mostly hampered by unreliable data on livestock mortality and by politically low set premiums.

**Keywords:** Livestock insurance, micro-insurance, rural finance, Vietnam

## Farming and Husbands

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Many attempts have been made to analyse the economic and social situation of women. With regard to rural areas and farming, discussion often focuses on female headed households (FHH). While investigating the links between FHHs and farming, empirical studies often find that FHHs face a wide array of disadvantages in obtaining agricultural inputs on the market. But closer inspection reveals that one can find several patterns of FHHs which do not necessarily share the same set of constraints. Qualitative findings from Sub-Saharan African Countries show that out-migrated husbands often leave their wives with low decision making competence thus lowering farming efficiency. Hence, out-migration of husbands forms a temporary FHH which might not be comparable to FHHs that evolved from divorce or spouse's death where no husband dictates decisions. Two major questions are emerging: **(i)** Is it possible to distinguish between several patterns of FHHs and do different categories show a different performance? **(ii)** Which role do men play?

Using data from the Kenyan Welfare Monitoring Survey III one can distinguish between four FHH categories: **1.** 'True' FHHs, where there is no husband at all. **2.** Married monogamous FHHs where the husband is temporarily absent. **3.** FHHs as part of polygamous household compounds. **4.** Married monogamous FHHs where the husband is present. After estimating a set of demand functions for agricultural inputs, the results show that it is not possible to aggregate all four categories into a single one, since all different classes show substantially different performances. FHHs which are part of a polygamous household compound and FHHs with a present husband have substantially less problems to obtain inputs on the market. Subsuming all categories under one single category would heavily bias the estimated parameters. The results suggest that policies aiming at improving the situation of FHHs should consider their particular circumstances.

**Keywords:** Agriculture, female headed households, input demand, Kenya

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## Empowerment of Rural Women in Bangladesh — A Household Level Analysis

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Although women constitute about half of Bangladesh population, their social status especially in rural areas remains very low. Rural women belong to the most deprived section of the society facing adverse conditions in terms of social oppression and economic inequality, a visible majority of them being extremely poor. Considering this scenario, this paper investigates the nature and extent of rural women's empowerment and factors influencing it. The paper further outlines a strategic framework for enhancing rural women's empowerment. The methodology of this study is an integration of quantitative and qualitative methods based on data collected in three villages of Mymensingh district. Six key indicators of empowerment covering three dimensions were chosen for this purpose. Data were collected from 156 respondents during January–April 2003 following stratified random sampling. Finally, a cumulative empowerment index (CEI) was developed adding the obtained scores of six empowerment indicators. The results of empowerment indicators show that 81 % of the women had a very low to low economic contribution, 65 % had a low to moderate access to resources, 81 % had a very poor asset ownership, 73 % had a moderate to high participation in household decision-making, 42 % had a moderate perception on gender awareness and 72 % had a moderate to high coping capacity to household shocks. The distribution of CEI demonstrates that the majority of rural women had a very low to moderate (82 %) level of empowerment. A significant proportion of the respondents had no formal (50 %) and non-formal (67 %) education, respectively. The multiple regression analysis shows that there were strong positive effects of formal and non-formal education, information media exposure and spatial mobility on women's CEI, while traditional socio-cultural norms had a strong negative effect. The study concludes that education, training and exposure to information media have the potential to increase women's empowerment. Therefore, effective initiatives undertaken by the concerned agencies in improving women's education, skill acquisition training and access to information could enhance women's empowerment in order to achieve gender equality and development at all levels in the rural society of Bangladesh.

**Keywords:** Bangladesh, empowerment, household level, rural women

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## **Technology Adoption and Household Food Security, Analysing Factors Determining Technology Adoption and Sustainability of Impact — A Case of Smallholder Peasants in Nepal**

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Nepalese agriculture is characterized by traditional subsistence oriented farming. The paramount important of this sector is reflected by its 39 % share to national GDP and absorption of 81 % labour force. Livestock sector is the major component that sustains agricultural system by providing more than 91 % draft power required to agricultural operation and more than 90 % of the total manure for food grain production. Some socio-economic and geo-physical factors have hindered apace both food grain and livestock production. Generation and diffusion of innovations are continued by an unflinching endeavor over the years, but in dawdling motion. Consequently, scanty of area coverage have been made by innovation. A with and without project approach was applied as a research methodology to test the hypothesis that technology adoption is determined by socio-economic, human capital factors, and project intervention irrespective of technological attributes and resource endowments. A household survey was conducted to collect primary data applying multi-stage random sampling procedure for 165 respondents. In addition, secondary information was also used. The collected cross sectional data was analyzed using descriptive statistics, econometric model and qualitative analysis. The econometric analysis revealed that farm size, credit, experience, education, off-farm income, project intervention and extension service are the determining factors of adoption since the coefficients of those variables are found positively significant at 0.05 and 0.01 probability level. The degree of adoption of improved animals is higher with treatment group (62 %) as compared to control (10 %). The number of saplings plantation, area allocation for forage cultivation and biomass production are found significantly different between the two groups at 0.001 probability level. Notwithstanding project intervention laid positive impact, the food security at household level was found not significant. Therefore, the extrinsic factors governing application of innovations should be on the top priority while executing policies. Moreover, intervention should primarily focus on either of the followings to increase food security: increase the level of inputs use, or improve the technology without increasing the quantity of inputs, or increasing the productivity of inputs by reallocating and combining them optimally from beneficiaries' perspective.

**Keywords:** Project intervention, technology adoption, rural households, food security, impact

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## **Agricultural Policies in Industrialised Countries and Rural Poverty in Sub-Sahara Africa — Is the Link Overvalued?**

MICHAEL BRUENTRUP

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In the context of the agricultural negotiations of the Doha Development Round of the World Trade Organisation (WTO), protectionism and subsidies of industrialised countries are often affirmed to be the main responsible factors for low agricultural prices and rural poverty in Sub-Sahara Africa (SSA). The author examines these allegations on the basis of two SSA countries with distinctive situations:

- Tanzania represents a strongly agriculturally determined economy with a relatively rich endowment of agricultural resources and a positive net agricultural export trade balance.
- Senegal stands for a (at least in a SSA context) relatively urbanised and industrialised economy, which due to lack of dynamics in agricultural development and the degradation of the natural resource base is rather dependent on agricultural imports and shows a negative net agricultural trade balance.

The study uses production, export and import profiles of the countries, reviews important agricultural world markets, and analyses trade and agricultural policies. It is concluded that, although the allegations of negative effects of industrialised countries' agricultural policies on SSA agriculture cannot be rejected, they are most probably not the decisive determinants for the lack of dynamism in these sectors and for rural poverty. More important are the internal agricultural policies of these countries which still have an urban bias, neglect agriculture and the rural areas and do not offer sufficient incentives for investment in rural areas.

It is improbable that SSA will be able to respond to potential incentives from a WTO agreement without a re-dynamisation of the agricultural sector. The most important areas of improvements are: Strengthening the private sector and peasant organisations, improving rural financial systems and credit availability, applied research and extension with due consideration of private sector interests, information and risk management as well as the complex issue of land use / land rights / natural resource management. Macro policies such as exchange rate and regional integration policies, infrastructure, decentralisation and general private sector strategies must take due account of the needs of the agricultural and agro-industrial sectors.

**Keywords:** Africa, agricultural policy, agriculture, liberalisation, poverty, world markets, WTO

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## **Agricultural Trade Liberalisation in the WTO and Its Poverty Implications — The Case of Rural Households in Northern Vietnam**

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The objective of the paper is to analyse poverty implications of the actual liberalisation discussions in the agricultural sector within the WTO negotiations for rural households in Northern Vietnam.

Within the liberalisation efforts during the last years the World Trade Organisation (WTO) played an important catalytic role. However, during the present Negotiation Round, also called the Doha Development Round, some drawbacks occurred and scheduled deadlines could not be met, especially true for the agricultural sector. In preparation of the Ministerial Meeting in Cancún, Mexico, in September 2003, the WTO suggested further liberalisation for the agricultural sector in the Harbinson Paper to break up the deadlock in the negotiations. Vietnam is currently not a WTO member but is in the process of accession negotiations. The objective of the Vietnamese Government is to accede to the WTO within the Doha Round by 2005.

The chosen methodology is a macro-micro approach which uses first a general equilibrium setting (standard GTAP model) to assess the price changes of the Harbinson suggestions for further agricultural liberalisation. Two scenarios are simulated: Vietnam being member of the WTO and Vietnam not being a member of the WTO. The data for the macro simulation are from the GTAP database.

In a second step data from a household survey from Northern Vietnam (2001) are used together with the price changes from the macro simulation to estimate poverty implications for the households. Within this post-simulation analysis household data are mapped to the GTAP data. In order to estimate the net income and poverty effects of trade liberalisation the income side (via factor price changes) and the consumption side (via consumption price changes) are considered. Households are classified following their income structure and their consumption shares for different product categories. Results show how rural farmers in Northern Vietnam may be affected by the countries accession to the WTO and how this affects their net income and thus their poverty situation.

**Keywords:** Agricultural trade liberalisation, general equilibrium model, macro-micro approach, post-simulation analysis, poverty,

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## **Chinese Rendered Animal Protein (MBM) Import Demand Estimation with Two Stage Budgeting AIDS and Source Differentiated AIDS Model**

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After decades economic liberalization, China has become the world's second largest producer of animal feed and China is the world's largest raw protein sources importing country. However, Chinese booming feed industry faced a rather different market scenario while raw protein source prices rose sharply, especially importing soybean meal and fish meal. This severely curtailed profit margins for feed industry. Lack of protein materials is placing continuous pressure on feed producers. Policy evaluations require reliable estimates of alternative cheap protein import demand responsiveness. The research is aimed to analyzing rendered animal protein (MBM) as an alternative cheap protein source and determine import elasticity of meat and bone meal (MBM) with respect to main importing protein sources (fishmeal and soybean meal).

Two stage budgeting AIDS and source differentiated model are specified to estimate Chinese rendered animal protein (MBM) import demand.

The results from both two stage budgeting AIDS and source differentiated model indicate that as raw protein imports increase, China imports more soybean meal and fish meal than rendered animal protein (MBM). Between soybean and fish meal, soybean meal has larger expenditure elasticity than fish meal. As expenditures on soybean meal increase, China imports more from Argentina and Brazil than that from U.S, while expenditures on fishmeal increase, fish meal from Peru is in the favourite source. Own-price elasticity for individual raw protein from different origins are all negative (with an exception for fish meal from Chile). For rendered animal protein (MBM), own-price elasticities are inelastic. This reflects quantity restrictions on rendered animal protein (MBM). With large import demand for soybean and soybean meal, Chinese imports from Brazil and U.S are price sensitive. Cross-price elasticities between rendered animal protein (MBM) and soybean meal is inelastic and negative, indicating weak complementary relation, while rendered animal protein (MBM) and fishmeal cross-price elasticity is price elastic and positive, describing substituting relationship. The study concludes that rendered animal protein (MBM) has limited to be used as cheap alternative protein source to substitute main importing protein source (soybean meal and fishmeal).

**Keywords:** AIDS, China, import demand, separability, substitutability, source differentiation

## **International Competitiveness of Small Scale Dairy Farms in Pakistan and India**

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The aim of this paper is to compare the current economic situation of average small-scale dairy farms in India and Pakistan and other important dairy regions in the world. Secondly to assume the question if these farms in India and Pakistan can compete with dairy imports in their countries and have the potential competitive edge for exporting dairy products. For the analysis, the two farms (one average size farm and other large size farm) are selected from each country in India, Pakistan, Brazil, New Zealand, Germany and USA. The study is based on the typical farm approach and using a harmonised accounting and cost analysis method developed by International Farm Comparison Network (IFCN).

The analysis shows that the average size small farms in India and Pakistan have milk production cost of US\$18–22/100 kg ECM (energy corrected milk), which is 23 % higher as compared to the cost of average size farm in Brazil and New Zealand. But at the same time they have the advantage of 50 % lesser costs than the average size farms in Germany and USA.

The large farms in India and Pakistan produce milk at a cost of US\$9–12/100 kg ECM, which have an advantage of 48 % lower costs than large size farms in Brazil & New Zealand. The average size farms with 1–2 milk animals in India and Pakistan are not competitive in the longer run as compared to average size farms in Brazil and New Zealand due to higher opportunity cost of family labour.

Nevertheless the large size farms with more than 10 milch animals in rural areas of India/ Pakistan are belonging to the most competitive farms in the world. These farms have the potential to compete with the dairy imports. With the competitive edge of lower milk production costs, these farms have the opportunity to export dairy products in international market as well if the milk-processing chain is organised in delivering the dairy products of international standards.

**Keywords:** Competitiveness, cost of milk production, dairy farming, developing countries, south Asia



## Market Efficiency of Fruits and Vegetables in Northern Thailand

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In mountainous areas of Northern Thailand the commercial production of fruits and vegetables has become commonplace for many farmers over the past two decades. Fruits and vegetables often fetch higher prices than staple crops but also are subject to higher production and marketing risks. Market prices for fruits and vegetables fluctuate due to the characteristics of the product such as quality, variety and shelf life as well as seasonality but also due to market inefficiencies. The objective of this study is to determine factors of market efficiencies and inefficiencies in the fruit and vegetable markets based on a case study in Northern Thailand. It is hypothesised that fruit and vegetable crops are diverse in their market efficiency due to the characteristics of the markets (i.e. market size), location of markets (i.e. income structure) and distance between markets. Weekly prices for mango, lychee, cabbage and carrot were collected for the year 2001 at one wholesale and ten retail markets in and outside of Chiang Mai City. In addition weekly Chiang Mai farm-gate prices and Bangkok wholesale prices were acquired for the same period of time from the Office of Agricultural Economics and Talat Thai Market respectively. In addition other quantitative and qualitative information was collected from interviews with 32 vendors, 30 traders and 11 market owners or administrators. Correlation coefficients by Pearson are used to analyse market efficiency by measuring the pricing efficiency and degree of integration between markets. In addition qualitative and quantitative data obtained from traders and market managers are included in the analysis to further determine the factors of market efficiency. The results show that market size and income structure have a significant impact on market prices. However, the impact distance between markets has on pricing showed mixed results. There is a correlation between the various markets for cabbage, but a lack in correlation for carrot, lychee and mango. Overall this study gives insight on fruit and vegetable markets, which are often neglected in research, and delivers answers on efficiencies and inefficiencies within these markets.

**Keywords:** Correlation coefficients, fruit and vegetable markets, market efficiency

## **Determinants of Commercial Orientation of the Individual Farms in Romania**

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In Romania during the transition period towards the market economy the performance of the agricultural sector has decreased while poverty has increased. These negative aspects have been related to the reforms in the agricultural sector, including the privatisation of land and the emergence of individual farms. Individual farms now possess the largest part of agricultural land as compared to other production entities, however they are constrained in their development by the lack of necessary assets and undeveloped output and factor markets. As a result of the constraints, individual farmers have increased self-consumption at the cost of marketed output sometimes to the extent that they do not sell output at all. The predominance of asset poor and market constrained individual farmers in Romania has contributed to the deterioration of the overall performance of the agricultural sector. Still it is little known what factors determine the commercial orientation of the individual farms in Romania, essential for increasing the performance of the agricultural sector in general and the living standards of the poor households in particular. The paper seeks to answer this question, specifically how the endowment of the households with factors of production and market imperfections through transaction costs influence commercial orientation. The methodology employed in the study consists of descriptive statistics and econometric analysis. The econometric analysis relies on a two-stage selection model, in a first stage the decision of sales and in the second stage the percentage of sales from total agricultural production are regressed on the different factors determining commercial orientation. The analysis is based on an agricultural household survey from 2003 collected as part of a Ph.D. research. The study concludes what factors are important for moving out the individual farmers of the subsistence trap and increase commercial orientation, beneficial for the agricultural sector and for the poor.

**Keywords:** Transaction costs, agriculture, commercial, individual farming, Romania, transition economies

## **German Consumers Image towards Argentinian Agricultural Products — An Approach to Develop New Products and Processes**

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Argentinian Agricultural Products are mainly exported with low added value and without any brand. One of the most important destinies of Argentinian agricultural exports is the European market. Furthermore, Argentina has the second largest organic production area worldwide which is further expanding. Argentinian organic products tend to have more added value than conventional products through processing and marketing. The objective of this paper are:

- To explore if the European consumer has build an image of Argentinian agricultural products.
- To evaluate if the factors conforming this image, most likely related to certain products, can be transferred to other products through marketing and communication strategies or, in special cases, be transferred to processing, resulting in new products.
- To evaluate if factors conforming the image of Argentinian products can improve the image of Argentinian organic products and add value by marketing strategies and processing.

The image of Argentinian agricultural products is explored by a questionnaire asking consumers about concepts, ideas, words and products that come to their mind when thinking in Argentina. Additionally, consumers are asked to rate their preferences for different quality aspects, such as environmental friendly production, chemical additives, free of child labour, fair trade, healthy etc. Results are related to German consumer statistics to see if they are representative and reflect the German consumer's behaviour. The trend detected so far seems to indicate that German consumers demand products free from chemicals and organic products. This could be a hint for the food export sector to direct more attention to organic products and marketing strategies emphasising the healthy character of Argentinian products. Recommendations on how to exploit the existing image of Argentinian agricultural products for marketing and communication strategies will be derived. This will contribute to the development of value-adding strategies for potentially marketable Argentinian agricultural products in Northern European markets and help to overcome the lack of information towards international markets in the underdeveloped Argentinian food export sector.

**Keywords:** Export, product image, consumer, marketing strategy, beef, Argentina, Germany, agricultural products

## Impact of the EU Accession on Competitiveness of the Estonian Milk Sector

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Estonia is well known for its extremely liberal economic and agricultural policies. Markets and prices were fully liberalised after regaining the independence in the beginning of nineties. Transition process towards the market economy has been fast. By the second half of the nineties the economy started to grow as the industry was underway with adjusting to the market conditions. However, agricultural production decreased by a half during the transition process and is still decreasing. With the accession to the EU agricultural sector will face another policy change, namely the introduction of the Common Agricultural Policy (CAP). The purpose of the paper is to analyse the impact of these policy changes on the patterns of competitiveness of the milk sector in Estonia.

Policy Analysis Matrix (PAM) serves as a methodological tool for the analysis. PAM is constructed both for milk production and processing industry in order to explore the impact of the CAP measures — that is broadly direct payments to the farmers and market intervention measures at the processed products level (i.e. export refunds, intervention and border protection). Scenarios with the EU policy measures are developed, where the input costs and revenues that are affected by the CAP are altered. The simulations show short term effect of the EU accession on competitiveness of the Estonian milk sector.

According to the preliminary results Estonian milk producers on the whole are not competitive. Export oriented milk processors are competitive, whereas the firms oriented to the domestic market are not. Competitiveness of the milk producers increases considerably shortly after the adoption of the CAP. The impact on competitiveness of the milk-processing sector is less favourable. In order to analyse the impact of the market intervention schemas of the CAP also on the milk production the assumption of the perfect price transmission along the agro-food chain (from processor to producer) is relaxed. The results show that the imperfect price transmission mitigates the expected profitability of the farm sector from the EU common Agricultural Policy.

**Keywords:** Competitiveness, Estonia, EU accession, milk sector, policy analysis matrix

## Sketching Private Participation in Agricultural Extension in Nigeria and Benin

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The importance of extension in the agricultural system is questioned due to its low effectiveness and efficiency in improving agricultural performance and consequently farmers' welfare. The objective of this research is to evaluate the feasibility and constraints for including private components into the public extension system in Nigeria and Benin, with emphasis on rice production. The study areas are located in Ogun, Kogi and Ebonyi states in Nigeria, and Dassa and Glazoue sub-prefectures in Benin. The work is divided in two parts. The first part focuses on information and knowledge as agricultural inputs provided by the extension services. The objective is to determine the value farmers give to information and from that estimate the farmers' willingness to pay (WTP) for information and extension services. The second part evaluates the constraints of implementing private components in the extension system and develops a framework in order to improve the efficiency and effectiveness of the system. WTP as estimated in the first part of this study is used as a reference to evaluate the financial constraints together with two new concepts, the farmer's capability to pay (CTP), and the farmer's requirement to pay (RTP). Technical and institutional constraints are revised through an in-depth stakeholder analysis, and human and physical resources are evaluated as well. The review of experiences around the world provides possible institutional arrangements that are discussed for the local conditions. First evaluations show that even though there is a positive attitude towards financial participation for rice extension, the sustainability of the system can be limited by the relative importance of rice crop in the area. Another important constraint is the availability of service providers qualified and motivated to accept the challenge. The use of coupons or vouchers to structure the system is under evaluation.

**Keywords:** Financial participation in agricultural extension, WTP for information

## **Structure- Conduct-performance Analysis of the Cocoa Market in the Vicinity of Lore Lindu National Park, Central Sulawesi, Indonesia**

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Since the introduction of cocoa in the early 1980s, it became a major export crop of Central Sulawesi/Indonesia. Nowadays, it is the most important cash crop of farmers. Therefore, the performance of the Cocoa market highly influences rural incomes as well as economic growth in the region. This study aims to analyse the current marketing system and to examine policy options to improve performance of the cocoa market.

The cocoa market in Central Sulawesi performs with only limited control from the local government. The market system is open to private traders without any involvement of marketing boards. In 2003, the share of price received by the farmers on average was 82 % compared to the border price of cocoa from Palu shipping port. The spread price was 18 % and it distributed to the middleman that interconnected farmers in producer side and importers in consumer side.

The spread price in each village and in different times varies depending on some influencing factors such as distance to the central market in Palu, roads and transportation vehicles. This paper will examine alternative option of policies by using market-conduct-performance approach completed by descriptive statistics to analyse the volatility of shares of each actor in cocoa market.

Primary price data was collected in 2002 and 2003 through standardised, formal questionnaires from 14 selected villages in the vicinity of the Lore Lindu National Park. The secondary data was gathered from various institutions related to the cocoa market.

**Keywords:** Cocoa marketing system, Indonesia, structure-conduct-performance

## **Transformations Within the Banana Industry to Protect Environmental and Worker Health**

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The banana is the most popular tropical fruit in the world, and six of the world's top ten banana exporting nations are located in Latin America. Latin American and Caribbean exports accounts for close to 69 % of world banana trade. Of the average 24 million metric tonnes of bananas produced yearly in Latin America and the Caribbean, 13 million metric tonnes are consumed locally. These fruits are usually produced on small plantations, while most bananas produced on the large plantations, generally run by the multinational companies, are destined for the export market.

Irrespective of the size of the production area, increasing awareness of the environmental and health impacts of banana production has affected plantation management. Improvements have been encouraged by international certification programs such as ISO. We have looked at the transformations that have taken place in banana plantations since the introduction of these certification programs. Specifically, we have concentrated on their impact on the environment in and around large banana plantations in Central America, as well as the effects this certification process has had on worker health and social conditions.

Positive changes are evident in waste management, which has improved with the creation of compost sites and the recycling of non-organic wastes off-farm. The incidence of pesticide handling accidents and worker intoxication have decreased in certain certified farms with the designation of special pesticide storage and preparation areas and changes in pesticide handling techniques, partially supported by agrochemical producers. Farm work during pesticide applications is suspended to additionally protect workers from dangerous contact with pesticides. Worker training in first aid and pesticide handling has had positive impacts on the acceptance and awareness of the advantages of using protective equipment while handling pesticides and contaminated material, both on the farm and in packing plants.

Unfortunately, these positive developments cannot be observed in all banana plantations nor throughout the banana production regions, therefore further improvements are needed to transform the banana industry into a genuine sustainable operation.

**Keywords:** Certification, pesticide handling, safety, waste management, worker training

## **Innovative Options for Market Access in Agricultural Engineering in the Ukraine Republic — the Example of an Investment Concept under Consideration of Selected Soil Treatment Systems**

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Like in many other east European states there is a high demand in the Ukraine to replace and to extend the used machinery parks to reach a profitable production. The problem posed is, that most of the Ukrainian farms are in a very difficult economic situation, particularly regarding liquidity. To access the interesting selling market for agricultural engineering, this bottleneck first has to be overcome. The presented study examines, which possibilities exist, to create new perspectives by establishing a partnership between an agricultural Ukrainian farm and traders of agricultural equipment. The objective is to improve profitability for both of the partners. The agricultural equipment trader has the advantage to be present with its machines on an interesting market under minimised risk.

The calculations were conducted for a model farm in Ukraine. The data sources were primary data to farm development possibilities by conducting intensive key person interviews in Ukraine. Secondary data were collected from traders of agricultural engineering, seed producers as well as literature review. The excel-based farm development programme MAX (Ströbel et al.) was used for the economic analyses of the enterprise.

The potentials of co operations between foreign traders of agricultural engineering and Ukrainian farms were examined at the model farm of a 400 ha cash crop farm in the Poltava region. Since main deficits were found in machinery availability for soil preparation, a focus was given to this point.

Soil preparation is so far particularly conventional conducted. Scientific research in more developed countries show, that under the existing frame conditions in Ukraine mulch seed or direct seeding are very promising procedures. The following variants were examined: conventional soil treatment systems with national technology, conventional technical systems with west European technology, Direct seeding with west European technology, direct seeding with west European technology. The results showed, that under the assumed frame conditions the use of direct seeding leads to a tremendous improvement of the profitability of the whole enterprise and increases net profit to 76.151 € by investing in according machines (machines costs 173.800 €).

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**Keywords:** Agricultural machines, market access, Ukraine

## Dairy Chains in Developing Countries — A Case Study of Southern Asia

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The aim of this paper is to understand the dairy chains that supply milk from the farmers to the consumers in urban areas in developing countries. A case study of south Asian countries is presented in this paper. In South Asia the milk produced by small farmers is mainly consumed on the farms for home consumption as raw milk and for processing into household dairy products (butter oil is very common product). Only the surplus milk (25 % of the total production) is transported to the urban consumers through various chains. There are three major types of these chains, **a)** Formal chain (processed milk, 3-3.5 % milk fat contents). **b)** Informal chain (fresh milk unprocessed milk, 3 to 4.5 % fat contents) **c)** Farmers direct sales (fresh milk, 4-6 % milk fat contents). The data used for analysis is collected through panel surveys from each of the one major market in selected countries. A comparative method developed by International Farm Comparison Network (IFCN) is used for the analysis of dairy chain and the margins. The transaction margins are calculated on the basis of one kilogram of raw milk, which is sold as fluid milk (3 to 6 % fats) and extracted cream in all of the chains. The results are based on first estimates. **Consumer prices:** Returns from milk and cream sales are highest in formal chain of Bangladesh, which is US\$ 0,48 per kg milk. The lowest consumer prices are in informal milk milkman chain of Pakistan as US\$ 0,24 per kg for unprocessed raw milk. **Farmer milk prices:** Highest milk prices are received by Bangladesh farmers at US\$ 0,32 per kg milk. Lowest milk prices are received by Pakistani farmers at US\$ 0,13 per kg raw milk. Indian farmers are receiving milk prices above US\$ 0,20 per kg raw milk. **Margins:** The milk margins from farmer to the consumers vary from US\$ 0,06 to 0,24 per kg milk with lowest in Pakistan informal farmer direct sale chain and highest for Bangladesh formal processed chain. In general the margins are lower in direct sales due to absence of extra cream sales. If the farmers are receiving higher milk prices, the consumers have to pay the higher milk prices as well to maintain the margins in the chain. **Formal vs. Milkman:** The Indian (Haryana) formal chain is more competitive by paying higher milk prices to the farmers and selling low priced processed milk to the consumers. In Pakistan/Bangladesh the informal chain seems to be more competitive.

**Keywords:** Consumer prices, dairy chain, developing countries, farmer milk prices, margins, south Asia

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## Poverty Reduction Strategies and Relevant Participatory Learning Processes in Agricultural Higher Education

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In most Poverty Reduction Strategy Papers (PRSP) developed by countries in Sub Saharan Africa, agriculture is said to be the key factor for economic growth. How can higher agricultural education, research and outreach help turn this potential growth into real growth?

A study has been carried out to investigate how government policy and action plans regarding PRSPs have influenced and supported five universities in Eastern and Southern Africa, and to what extent these universities have responded to their national strategies for poverty reduction in terms of changes in their teaching, training and research programs.

The study is based on interviews with relevant persons in ministries, universities, the private sector, farmers' organisations, NGOs and others. In general, the respective Poverty Reduction Strategy Papers contain little about tertiary education, particularly about agricultural higher education. In the Tanzanian PRSP agricultural education is not mentioned at all. In the Malawian strategy paper a reduction in the reliance of higher education on Government subventions is proposed.

The findings indicate that higher education policies to promote economic growth in the agricultural sector are less than optimal, and that support to primary education and health is taking the lion's share of development budgets

Further, the results indicate that while higher education institutions in agriculture are committed to their work, limited financial resources are hampering their efforts. There is a clear intention to improve the relevance of curricula by including entrepreneurship to equip students to become job creators rather than job seekers. According to students, there should also be more emphasis on practical training.

The universities were criticised by NGOs and the private sector for not being up to date. More interaction between higher education institutions in agriculture, the private sector and society at-large is desirable.

**Keywords:** Agriculture, higher education, participatory learning, poverty reduction strategie papers (PRSP)

## IPM-FFS Impact Analysis — A Case Study of Cotton Production in Shandong Province, China

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Farmer Field Schools (FFS) in developing countries are a hotly debated issue. Though it is widely agreed that they are a modern way of providing a better ecosystems understanding for farmers and evidence of significant yield impact and cost savings exists, their fiscal sustainability and their cost-effectiveness are questioned.

Cotton is one of the most important crops in China, covers more than 5 Mill. ha and annual production is about 4.5 Mill tons on average. It is mainly cultivated on small-scale family farms. Pest pressure in cotton is relatively high and large amounts of pesticides are applied to protect the crop.

Twice the amount of pesticides is applied to cotton per unit acreage compared to rice, 4 and 7 times more as applied in wheat and corn production, respectively. This excessive reliance on pesticides inevitably poses serious problems e.g. to the environment, human health and can cause resistance in target pests. That is why from the year 2000 on the FAO-EU IPM Program for Cotton in Asia started to train farmers in integrated pest management in six Asian countries (Bangladesh, China, India, Pakistan, Philippines and Vietnam).

The paper uses a “difference in differences” (DD) model to evaluate the impact of FFS training in Shandong Province, China, on important farm-level outcomes such as gross margin, yield and pesticide expenditures. Based on panel data collected before and after the project was conducted, the results indicate that, compared to the control group of non-trained farmers, FFS participants had significantly higher gross margins and yields, while cost of pesticides decreased remarkably. For the third group of exposed farmers, who did not attend the training but live in the same village, no significant difference is found with respect to the growth rate of gross margin and yield, but pesticide cost were reduced significantly.

**Keywords:** China, cotton, difference in difference model, farmer field school, impact assessment

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## Impact Assessment of Farmer Training in Developing Countries

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Farmer field school (FFS) training is part of a FAO programme in Mali, Burkina Faso and Senegal that started in 2001. Training activities concentrate on rice and vegetable crops with the aim of **i**) improving farmers' agronomic practices (e.g. transplanting of rice, production and application of compost) in order to increase yields and **ii**) reducing pesticide use via introduction of integrated plant and pest management (IPPM).

Preliminary results show that under the West African conditions (prevailing lack of irrigation, limited production technology knowledge), the yield impact of farmer training can be significant.

A pooled data set from all three countries containing information on the training attendance and drop out rates, facilitator characteristics and performance, outcome of FFS experimental plots (IPPM and Farmers' Practice) from each field school (250 FFS) as well as household data from some 600 farmers (field school participants and control group) is used for the impact assessment.

The analysis consists of two steps, firstly looking at the performance of training and secondly the impact of training by assessing technology adoption at the farm level. The methodology used provides a measure of the quality of training and the short-term impact of training on crop production performance. The fact that training quality has an impact on the farm level adoption is often ignored in assessment of farmer training.

By pooling data from several countries and different crops, factors that limit impact of farmer training can be identified and potential impact of training for each crop and country can be assessed. The results of the impact assessment show the huge potential that farmer training has under the West African conditions to improve farmers' livelihood. It is anticipated that this kind of information is useful for the ongoing debate on the profitability and suitability of farmer training.

**Keywords:** Farmer field schools, farmer training, impact assessment, West Africa

## Using Indigenous Knowledge to Strengthen Local Governance and Development in Nigeria

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Indigenous knowledge is now perhaps “the single largest knowledge resource not yet mobilised in the development enterprise”. For a long time African customs and traditions were misperceived as irrational and incompatible with the conventional strategies for development and modern management. But with the economic crisis of the 1980s and '90s, and the policy failures associated with the formal government system, there is renewed interest in the cultural dimension of development, and the need to take local knowledge and practices fully into account in the development process. Enlisting indigenous knowledge and institutions in this way is in line with the current advocacy of the minimalist state and the ‘enabling approach’ as conditions for good governance in a period of structural adjustment and public sector reform. Governments in developing countries are urged by donor agencies, and are in fact obliged to limit their role to what their dwindling resources and capacities permit, to decentralise the structure of governance, and to promote partnership with non-state actors, including traditional leaders and institutions, the informal sector, and other organisations of civil society.

This paper considers how indigenous knowledge and institutions can be put to good use in support of local governance and development in Nigeria; how development policies and programmes can be made to reflect local priorities, and to build upon and strengthen local knowledge, organisation and capacity, especially in the vital areas of education and health care, agriculture and natural resource management, conflict resolution and law reform, environmental protection, sanitation and so on. The paper will question the uniform, single-tier structure of local government introduced in Nigeria in 1976 for both rural and urban areas, and review the series of policy reforms in the 1980s and '90s designed to link and reconcile “the informal indigenous institutions rooted in the region’s history and culture, and formal institutions mostly transplanted from outside”.

I will conclude with some general reflections on the indigenous knowledge movement as an appropriate local response to globalisation and Western knowledge dominance, and as a means to promote inter-cultural dialogue on African development.

**Keywords:** Community participation in development, decentralisation, growth with equity, indigenous knowledge, local governance, traditional wisdom

## Establishment of the Centre of Agricultural Education in Bie Province, Angola

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A long civil war in Angola was finished only two years ago. The consequences have deeply influenced the whole country, in particular the economy situation. The priority of the post-war rehabilitation is re-encouraging food security of the country which is obviously connected to the development of agriculture. The aim of this project is establishment of agricultural educational centre in the province Bie (located in the central Angola and occupying 72,000 km<sup>2</sup>). The establishment of the centre will help in solving food problems and at the same time in generating of new labour opportunities. The educational activity of the Centre can also support local governmental effort to prevent from migration of rural inhabitants.

The project has been realised as a bilateral development project of Czech Official Development Assistance. The involved partners are Institute of Tropics and Subtropics / Czech University of Agriculture Prague, Ministry of Education, Youth and Sports on the Czech side and Ministry of Agriculture and Rural Development, Ministry of Education and Ministry of Foreigner Affairs and Government of Bie on the Angolan side; apart from these the cooperation of local FAO representatives is ensured. The project duration is three years with the budget of 8 mil. CZK (€266,600).

The project implementation is in its second year now. The preparation phase including localisation of a suitable place for the Centre in Kuito, provision of teaching materials and equipment for theoretical and practical training and preparation of syllabus and study programs of the Centre, was finished. The four-membered team has started teaching hundred students in March. The partial aims to be fulfilled this year are establishing poultry breeding (training and food) and providing continuous extension services for local farmers. The long-term aims include opening of agricultural centre in Andulo, reconstruction of the research station in Ceilunga (cooperation with FAO) and upgrading the Centre to the Polytechnic Institute.

**Keywords:** Agriculture, Angola, Czech official development assistance, education, rural development



## **Regional Approach to Technical Training and Capacity Building for Improving Livestock Productivity in West Africa**

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Over the years, the International Trypanotolerance Centre (ITC) in Banjul has strengthened the activities of training and capacity building linked to its R&D agenda in the sub-region, namely in The Gambia, Senegal, Guinea, Guinea-Bissau and, more recently, in Sierra Leone. The concept and implementation of capacity building in the framework of the EU-funded Programme Concerté de recherche-développement en Afrique de l'Ouest (PROCORDEL) as a regional livestock research network have been presented at the DTT 2003 in Göttingen<sup>a</sup>. The main target groups were technical, scientific and extension personnel of the National Agricultural Research and Extension Systems (NARES), and the ultimate beneficiaries of R&D outputs, namely livestock farmers and other persons in local milk marketing chains.

This paper presents the methodology and preliminary results of a recent in-depth assessment study of the impact of the training components of PROCORDEL and of ITC's institutional programmes.

Building on previous experience and achievements, and conscious of the continuous needs for human resource development, ITC has developed a proposal for a follow-up project on regional training and capacity building with a focus on improving the productivity of low-input and market-oriented livestock production systems. With the overall objective of rural poverty reduction through research for sustainable development, the guiding principles of this approach include the promotion of regional integration and identity, and stakeholder partnerships including the private sector.

The specific objectives of the project are to continue targeted training for researchers, extensionists, and farmers to strengthen their skills, facilitate networking between all stakeholders, and to enhance the harmonisation, transfer and uptake of innovative technologies. The concept involves the NARES as recipients as well as providers of training inputs, with other institutions, organisations and stakeholders collaborating (Universities — South; Universities & ARIs — North; Farmer Organisations; NGOs, Regional/Sub-regional Organisations).

The paper describes the approach and key elements of the proposed project.

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<sup>a</sup>S. MÜNSTERMANN, A. SCHÖNEFELD: Capacity Building Applied to a Livestock Research Network in West Africa to Enhance the Development Process. DTT, Göttingen (2003)

**Keywords:** Capacity building, ITC, livestock productivity, training, West Africa

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## Education and Qualification for Rural Development

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Formal and non-formal qualification concepts broaden the development potentials of rural communities. The expanded access to quality basic education and qualification for all contributes therefore substantially to poverty reduction. In order to address the complex requirements of rural areas, education and training concepts (organisation and contents) need to be adapted to the local context. Non-formal qualification training in particular needs to offer opportunities for life-long learning in all aspects of the rural livelihood. Recent changes in the political and economic framework are affecting rural areas (i.e. decentralisation, deconcentration, market orientation, privatisation) and the livelihoods of the rural population. They demand a lot more self initiative, participation as well as organisational, cooperation and communication skills that have to be acquired. Comprehensive skills development strategies need to enable people to become technically competent, self conscious and active citizens. The necessary qualifications include primarily technical and micro-economic skills, as well as the ability to innovate agricultural production. These are the basis to overcome subsistence production towards market orientation and to develop non-agricultural job opportunities. Parallel to these “hard skills”, also “soft skills” such as self-organisation on village level, collective conflict management and democratic development need to be integrated in qualification programmes. Hard skills in the sense of technical production information have been transferred for a long time by agricultural extension (public and private). Farm-economic topics on market orientation and the concept of value chains were added more recently. Due to insufficiently formulated demand by the rural population, most extension topics though are still supply side oriented. Innovative training approaches attempt to develop both hard and soft skills for rural people. This promises sustainable changes in attitudes and behaviour on individual, organisational, society and political levels. Examples are projects of the German development cooperation in the Cote d'Ivoire, “Rural Training Networks”, and in Cameroon, “Self Help Promotion”. Public and private training and qualification service providers still have enormous deficiencies in skills for organisational development, process management and participatory approaches. These service providers need first to be qualified before they can implement skills development strategies for the rural population effectively.

**Keywords:** Education, rural development

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## **Agricultural Knowledge and Information Systems in Myanmar — Implications for Technology Dissemination and Development**

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This paper reports on a study of agricultural knowledge and information systems undertaken by the Central Agricultural Research Institute and the Agricultural Extension Division under the Myanmar Agriculture Service. Field research was conducted in three districts which are located in different agro-ecological regions of Myanmar. The core objectives are to assess the significance of different actors and organisations as potential uptake/dissemination pathways for agricultural technologies, and to consider ways to improve the performance of the knowledge and information systems in Myanmar. Technology refers to the combination of knowledge, inputs and management practices which are used together with productive resources to gain a desired output. Transfer of technology is not merely the means of transferring knowledge, information and skills about technology to its potential users but also way of helping them to use these technologies fruitfully to their advantages. The transfer of technology to the farmers in a social system is a very complex and complicated matter. Although the government extension is a major source of information in all the communities investigated, neither the communities nor the extension personnel themselves were satisfied with the quality or frequency of interaction. NGOs and UNDP are also important sources of information in those areas where they are active. The major sources of knowledge for small holders are friends, relatives, neighbours and markets. Most farmers considered that their most pressing information requirements which were not being adequately addressed were information on technical details of farming (e.g. chemical fertiliser application rates, where to get certified seeds, the most appropriate varieties for a given location, soil and water management, housing and management of livestock, etc.) market information, and input prices and availability. For the successful dissemination of agricultural technologies to a majority of farmers, it is a greater need to improve the performance of the agricultural knowledge and information systems by assisting farmers in ensuring adequate amount of knowledge about technologies and other information.

**Keywords:** Knowledge and information systems, Myanmar, technology dissemination



## Subsession 2c: Food and Public Health

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## **The Impact of Food Safety Measures on Small Producers in Developing Countries — A Case Study of the Moroccan Tomato Sector**

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The paper provides first results of a ongoing dissertation about the impact of food safety measures on the economic situation of small producers in the Moroccan tomato sector. In the European Union which is the main market for the Moroccan tomato production food safety has a top priority on the political agenda and the importance of private food safety initiatives is increasing as well. This trend demands various compliance activities from suppliers of developing countries to receive further market access and stay competitive in the world food trading system.

The basic hypothesis of the work is, that higher food safety measures have a specific negative impact on the competitiveness and market participation of small producers. It is assumed that higher food safety measures lead to the exclusion of small producers from the export sector and consequently have a negative effect on rural poverty.

After two empirical surveys in Morocco, it can be said that it is important to distinguish between the impact of the official EU standards and the impact of the private initiatives. This difference can be traced to divergent impacts on the production cost structure. The official measures demand a high level of human capital of the producers and the organisational and information structure of the sector while private initiatives extend these demands by additionally arising direct capital cost on the producer level. The surveys show, that the impact of official EU standards on producers whether for small or for larger farms is, due to the existing structure of the export sector, neglectable while the increasing importance of private standards shows a tremendous impact especially on small producers.

The paper starts with an economic classification and definition of food safety measures. This is followed by an overview of the different standards affecting the producer level in the tomato sector in Morocco. An analysis of the economic impact of the measures on producer level will be discussed and will provide the basis for a discussion of structural and social changes in the agricultural export sector engendered by the increasing importance of food safety measures.

**Keywords:** Food quality, food safety, Morocco, SPS

## Poverty, Food Systems and Nutritional Well-being of Children in North West Syria

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Linkages between child nutrition, the food system and socio-economic status in households dependent on different forms of agriculture were traced in a study conducted in North West Syria. Two areas of study were identified and three livelihood groups were selected. These were the barley/livestock/wage labour; the olive/fruit tree and irrigation groups. Five villages were surveyed and households with children under 10 years of age were recruited ( $n = 207$  households, 740 children). Informal interviews, seasonal calendars, key informant socio-economic characterisation, food frequency questionnaires and health questionnaires were conducted. Child height and weight data were collected in all groups and in a reference group from a middle class Aleppo city neighbourhood. Z-scores were calculated and independent sample t-tests and One Way ANOVA were conducted. Stunting was highest in the barley–livestock group (23 %,  $p < 0,05$ ) and lowest in the irrigation group (12,5 %), girls in the barley-livestock group had the highest rates (28,3 %), followed by the boys (22 %) and the girls (21,08 %) in the olive/fruit tree group. Underweight prevalence was highest in the barley—livestock and olive/fruit tree groups (14,29 % and 13,25 %). At the dietary level, the barley/livestock group had the highest mean monthly seasonal food frequencies for cereal and cereal products and lowest frequencies for animal protein foods. Differences were observed in socio-economic status across three livelihood groups Barley-vestock and the olive / fruit tree group reported the highest percent of poor households (60 %). In contrast the irrigation group reported more than 50 % of the households in a middle class category. In the barley livestock village, total land, number of sheep and sheep fattening increased with improvements in well-being category and seasonal wage labour was an important source of income for the two lower categories. The barley/livestock group had the poorest indicators of child growth, household food availability and socio-economic status. Marginal environments and poor access to resources are possible causative factors. The paper makes recommendations for addressing the nutritional deficiencies of these dryland marginal areas.

**Keywords:** Agriculture, food frequency, nutrition, poverty, socio-economic status, stunting, Syria, underweight

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## **Economic Valuation of Health Benefits through Farmer Training in Nicaragua — A Willingness to Pay Approach**

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While pesticides have been an important means of protecting plants from pests or diseases and thus increase productivity in plant production in modern agricultural systems, they also result in negative impact on the environment and on human and animal health. If these effects are not taken into account as costs associated with pesticide use or if they are external to the farmers, pesticide productivity is overestimated and pesticides are overused.

Vegetable farmers in Nicaragua use high quantities of chemical pesticides; occupational poisoning has been well documented. In a survey, we found that on average 14 applications with highly toxic insecticides during the four months cultivation period are carried out and annual intoxication rates are as high as 12 %. Demand for information and techniques that avoid exposure to toxic chemicals is high amongst farmers in the region.

This study assesses the benefits attributed to farmer pest management training with emphasis on health issues amongst a sample of 400 vegetable farmers in Nicaragua. The impact of training on the exposure of farmers to health threatening pesticides is identified and the resulting health costs/benefits are valued in economic terms. Our methodology allows evaluating the health risks due to pesticide exposure from the farmers' point of view. The analytical procedure shows the importance of health aspects in farmers' decision making. The study makes a contribution to better understand the incentive schemes required that induce farmers to adopt healthier technologies. In particular, it provides evidence on the full benefits of IPM programmes based on farmers' willingness to pay. Results of the study will help to design more effective health policies for the rural population in Central America.

**Keywords:** Human health, Nicaragua, pesticides, vegetable production, willingness to pay

## **Organochlorine Residues in Sudanese Workers of the Gezira Agricultural Scheme — Relations with Chronic Health Impairments?**

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DDT and other pesticides were extensively used in Sudan to control agricultural pests and vectors of malaria, typhus, yellow fever and sleeping sickness. Since 1981, DDT use in Sudan is restricted to public health purposes.

The Gezira scheme is the most important agricultural unit in Sudan producing cotton, sorghum, wheat, groundnuts and vegetables. With regard to pest management, the total amount of pesticide used in 1995/96 was 65 tons organochlorines (OC) and 68 tons organophosphorous pesticides.

OC tend to accumulate in the fat storing tissue of the human body to reach levels considered significant OC burdens. OC can lead to chronic intoxications that are characterised by deterioration of the nervous, digestive or cardiovascular systems, of blood formation processes and others. Limb tremor and alterations in the electromyograms have been observed with workers exposed to OC or other pesticides. It appears that no protection clothing is available appropriate for Sudan's hot climate.

To investigate whether there is a correlation between pesticide concentration in the blood and often observed health impairments such as chronic headache and tremor, 60 male workers of different occupational groups were examined. Results will be presented of the relationship between the concentrations of DDT (metabolites included) determined in blood sera and various health impairments deplored.

**Keywords:** Chronic intoxication, DDT, health protection, pesticides

## **Dietary Pattern and Socio-economic Status of Rural Households in Marginal Areas of North West Syria**

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The study was conducted in the Khannaser valley, a semi arid area on the fringe of the Syrian steppe, located 80 km south east of the city of Aleppo. It was part of a lysine fortification trial and its objectives were to evaluate the dietary and socio-economic status of households in such marginal areas. Three villages were selected on the basis of using homemade wheat bread (n=98). Interviews were administered in two parts, one week apart and included a structured questionnaire on income sources and a seven-day food inventory/intake questionnaire to estimate household food intake. In the latter, household sizes and exact number of individuals consuming each meal were collected and converted to adult equivalent units using the male adult requirement as reference. This procedure was used due to the common platter system, which does not allow easy reporting of individual food intake. Mean per adult male capita availability of food energy was  $2650 \pm 806$  kcal with  $70.1 \pm 26.45$ g total protein of which  $65 \pm 14$  % was cereal in origin. The lysine availability was  $41.9$  mg/g protein which is lower than current adult requirements. Estimated protein value of the diet was poor with high levels of cereal protein and low levels of animal ( $22 \pm 13.7$  %) and legume proteins ( $2.4 \pm 0.4$  %). Analysis of the socioeconomic status revealed that main sources of income were agricultural wage labour (83 % of households) followed by cropping (69 % of households), livestock sales (46 %), livestock husbandry (12.7 %), non agricultural wage labour in Syria (20 %) and abroad (23 %). Within agricultural wage labour, multiple activities were common (total of 6 activities) and almost 63 % of the total interviewed households reported anywhere from 2 to 6 activities per year. The most common wage labour activities included cotton picking (70 % total households), olive picking (33 %), lentil harvesting (22 %) and barley/wheat harvesting (19 %). In summary, household diets in Khannaser valley were largely dependent on cereals and the protein value of the diet was marginal. Household income showed a large dependence on wage labour, which was seasonal and unreliable that increased household vulnerability.

**Keywords:** Dietary pattern, household vulnerability, protein value, rural households, socio-economic status, Syria

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## Who Is More Competitive in the Dairy Chain in India — Formal vs. Informal

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The informal sector is the dominating channel in handling 80 percent of milk processing and marketing of milk and dairy products in India. The paper looks into some of the forces responsible for their dominance even under foreseen liberalisation of agricultural trade conditions. The study uses a case study approach to analyse the dairy chain involving the most common milk products handled by the organised and unorganised sectors in the state of Orissa, India. Orissa is a state where 95 % of milk is still handled by the informal sector. IFCN (International Farm Comparison Network) methods are utilised for the analysis of costs of milk production and margin analysis. This case study involved two channels of dairy milk processing, the formal cooperative milk union and the informal milkman. The product studied was the most common product marketed namely, fluid milk (2.5 to 3 percent fat content). The farmers price of milk (4 % fat) paid by the milkman was 11.5 percent more, the consumer price lesser by 22.7 percent. The value addition margin per litre of raw milk processed was lesser in the informal sector by 78 %. The milkman is adulterating the milk with 400 ml of water per litre of raw milk to bring down the fat content to 2.5 %. Hence, the processing and marketing costs for the milkman was lower by 273 % per litre of raw milk handled leaving a higher cash net margin by around 50 % of the formal channel. This could clearly explain the reason for dominance of the informal sector in milk markets in Orissa, with both the farmer, consumer and the informal milk agent (milkman) being benefited more in the process, though the milk quality by the informal sector is much worsen than that in formal sector. Due to lack of quality awareness and adequate infrastructure to cater to urban market demands is making the informal channel more competitive and thus dominating the milk markets in India.

**Keywords:** Competitiveness, cooperatives, dairy chain, food, formal, informal, markets, milk, quality

## Potential of Native Leafy Vegetables Production in North-Vietnam

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The consumption of vegetables in Vietnam increased in the past decade and nowadays, for example, each person in Hanoi (adult and children) consumes about 37–50 kg of vegetables per year. It is nevertheless much fewer than in other countries in the world (e.g. Germany 81 kg per capita). Vegetable production of the whole country have to reach 11.59 million tons till the year 2010 to improve per capita vegetable consumption to 90–100 kg per annum with 35 % of leaf vegetable, 40 % of fruit vegetable, 15 % of spice vegetable and 10 % tuber vegetable. The Red River Delta (RRD), one of the seven ecological regions of Vietnam, includes 9 provinces Ha Noi, Hai Duong, Hung Yen, Hai Phong, Thai Binh, Ha Nam, Nam Dinh, Ninh Binh and Ha Tay with 671,800 ha agricultural land, 2.643 million farm households and 10.596 millions farmers. The average of cultivated land per household is 0.25–0.3 ha. RRD is the largest vegetable producing zone of Vietnam with a climate suitable to many kinds of leafy vegetables. Vegetable output was 1.658 million tons (1999), accounting for 31.6 % of that of the country's production. In winter season, each household grew two to eight kinds of vegetable (cabbage, kohlrabi, cauliflower, and so on). The other months with high temperatures are suitable for leaf vegetables with tropical origin; especially June, July and August (28.0 to 30.7 °C) are suitable for growing of vegetables like Water spinach, Malabar spinach, Sauropus, leafy cabbages (Mild Greens), Amaranth etc. The nutritional value of these leafy vegetables is very high due to the high content of protein, iron, calcium, vitamins C, and A (carotene). Currently these leaf vegetables are cultivated in small household gardens. For saturation of the market demand new technologies for field production of leaf vegetables in a large scale are to develop. Very important is the introduction of cultivation methods for clean vegetables with low residues of pesticides and nitrate content.

**Keywords:** Cultivation technologies, leafy vegetables, Vietnam

## **Improved Integration of Underutilised Crops into Farm Household Economies — The Case Study of *Vernonia calvoana* (HOOK) in the High Land Zone of Cameroon.**

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Poverty reduction is the focus of many developing countries' development policy strategy. In Cameroon, the Poverty Reduction Strategy Paper reveals that eight people out of ten live in the rural areas where they are in gross lack of basic needs.

Underutilised crop species play possibly an important role in the food security and income generation of the rural poor. This study considers the case of *Vernonia calvoana* (HOOK) and seeks to value its sustainable contribution to welfare at the household level. It assumes that this species can increase income and improve food security at the household level. Questionnaires are submitted randomly to 105 households in Menoua Division.

Furthermore, plants are renewable resources that may be subject to genetic erosion if not carefully managed. This is relevant in the in the West High Land Zone of Cameroon where the situation of the poor is more difficult owing to growing urbanisation, population growth pressure and consequential environmental problems. The environmental and socio-economic factors and their interaction with the genetic erosion will be analysed. The study area is subdivided into three blocs according to one environmental and two socio-economic variables: elevation, level of urbanisation and level of preference (taste). Within each bloc, agromorphological variations of individual plants are characterised and evaluated to make out the existing patterns of diversity.

Based on the contribution of the species to welfare and its distribution according to environmental and anthropic factors, an analysis of its sustainable integration into rural farm household systems is made.

**Keywords:** Underutilized crops, rural welfare, food security, household income, *Vernonia calvoana*

## Effects of Fattening on the Occurrence of Sheep Abscess Disease (Morel's Disease)

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This study was carried out in the Sudan to find the relation of fattening to Abscess Disease in sheep. The incidence of the disease was found to be higher in feedlot areas (62.5 %) compared to natural grazing areas (5.8 %). Pus samples, sweat samples, serum samples were collected from both fat and non-fat sheep.

Bacteria isolated from pus samples of feedlots were *Staphylococcus aureus* subspecies *anaerobius* (75 %), *Corynebacterium* spp. (15.8 %), mixed infection of *Staphylococcus aureus* subspecies *anaerobius* and *Corynebacterium* spp. (8.3 %) and 2.5 % of samples were bacteriologically negative. Samples collected from the slaughtered-house showed *Staphylococcus aureus* subspecies *anaerobius* in a rate of 25 % while *Corynebacterium* spp. in a rate of 75 %.

The pH of the sweat is found to be 5.0–6.0 for non-fat sheep (in natural areas) and 6.2–7.5 for the fat sheep (in feedlot areas). Traces of cholesterol were detected by Thin Layer Chromatography plates for fat sheep (15 out of 20) and not detected in non-fat.

The cholesterol level in both fat and non-fat sheep in mg per dl were  $74.06 \pm 05.56$  for fat sheep and  $43.00 \pm 04.66$  for non-fat sheep.

Cholesterol was detected in small amounts in the sweat and in high concentrations in the fat sheep sera. It enhanced the growth of *Staph. aureus* subspecies *anaerobius*  $7.5 \times 10^7$  CFU/ml when sterile fat sheep sera was added and  $5 \times 10^6$  CFU/ml with sterile non-fat sheep sera.

*Staph. aureus* subspecies *anaerobius* was grown in vitro in brain heart broth media with different pH values and the results showed that the organism was able to grow at pH 7.5 and failed to grow in acidic pH.

**Keywords:** Abscess, fattening, sheep, *Staphylococcus*, Sudan

## Studies on Pathological Changes of Condemned Lungs of One Humped Camels (*Camelus dromedarius*)

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This study was carried out in Tamboul slaughterhouse (Butana region of the Sudan) and Nyala slaughterhouse (western region of the Sudan) to investigate the condemnation causes of Dromedarius camel's lung. Two hundreds and six camels were inspected at post-mortem in both areas (136 camels in Tamboul and 70 camels in Nyala abattoirs). The main causes of lung condemnation in Tamboul were found to be parasitic (hydatidosis) 40.4 %, pneumonia 19.1 %, abscess 2.9 %, caseated nodules 8.8 %, emphysema 6.6 %, necrosis 5.9 %, fibrosis 4.4 %, adhesions 1.5 % and aspirated blood 2.2 % while in Nyala the causes of condemnation were found to be hydatidosis 61.4 %, pneumonia 31.4 %, abscess 8.5 %, caseated nodules 5.7 %, emphysema 2.9 % and fibrosis 12.9 %. Grossly 35.7 % of the total hydatidosis infection (98 lungs) found to be associated with other pathological lesions. Nevertheless, the adjacent hydatid cyst sections showed pneumonic changes viz: emphysema, oedema, atelectasis, alveolar congestion, peribronchial lymphoid tissue hyperplasia and interstitial pneumonia. *Suppurative pneumonia* (bacterial) causes that detected as 32 % of the total condemnations and the microorganisms involved were, *Staphylococcus* spp. 27.9 %, *Corynebacterium* spp. 13.9 %, *Streptococcus* spp. 13.9 %, *Bacillus* spp. 12.8 %, *Pneumococcus* spp. 11.8 %, *Enterobacteria* spp. 9.6 %, *Micrococcus* spp. 6.4 %, *Haemophilus* spp. 2 %, *Actinocyetes* spp. 1 %, *Pasteurella* spp. 1 % and *Pseudomonas* spp. as 1 %. Experimental infections in rats with different representative isolates were conducted using intraperitoneal, intramuscular and subcutaneous routes. The inoculated isolates were not produce deaths in rats up to 15–17 days post inoculation. However, post-mortem findings in some rats inoculated intraperitoneally showed congestion of lungs, heart, liver, liver fatty change, hydropic degeneration of kidneys and visceral congestion. The histopathology of pneumonic bacterial sections showed purulent bronchopneumonia, abscessation, haemorrhages, fibrinous exudation and interstitial pneumonias. The lymph node sections stained with H&E showed various degrees of lymphadenitis. The sections stained with Zeihl Neelson stain revealed acid fast tubercle bacilli in one section.

**Keywords:** Camel, condemned lung, dromedarius, pathology

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## Investigations on Citrus Virus and Virus-like Diseases and their Spread in Citrus Orchards in Semi Arid and Savannah Zones of Sudan

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The Sudan is situated within the citrus belt and hence this country offers great potentialities for citrus production. The following citrus species have been introduced to the Sudan and are now mainly grown: baladi (Local) lime (*Citrus aurantifolia*), grapefruit (*Citrus paradisi* MACF.), sweet oranges (*Citrus sinensis*, OSBECK), lemon (*Citrus limon*) and mandarins (*Citrus reticulata*, BLANCO). Fruits are consumed domestically, the surplus is exported to Saudi Arabia, the Gulf States and Europe. Different citrus diseases have been observed in the citrus growing areas of the Sudan by visual inspection, indicating that the commercial citrus varieties are heavily infected with virus and virus-like diseases. These pathogens cause varying degrees of damage affecting quality and quantity of the product as well as the vigour and longevity of the trees. Additionally a new citrus disease, which has not been reported in any other citrus growing areas in the world, was found to occur in the Sudan. It was referred to “Kassala disease” or bark gumming of grapefruit and was first described by BOVE (1986) on Foster grapefruit trees in Kassala area.

Up to now, there was no serious work in the diagnosis of citrus diseases occurring in Sudan by other methods than visual inspection. Therefore surveys on citrus virus and virus-like diseases were conducted in 2003 throughout twenty locations in seven regions covering the main citrus growing areas of the Sudan. All together over eight hundred trees were examined. Based characteristic symptoms with diagnostic value different citrus species (sour orange, grapefruit, mandarin, and baladi lime) seem to be infected with *Citrus tristeza virus*, *Citrus variegation virus*, *Citrus psorosis virus*, different viroids (*Cachexia*, Gummy bark), *Phytoplasmas* (Witches’ broom, Stubborn) and Kassala disease (unknown aetiology) respectively. Leaf material was collected and prepared to be analysed by using different methods. Biological indexing was carried out using a set of indicator plants. In addition serological (ELISA) and molecularbiological (RT-PCR) methods are applied. The occurrence and distribution of selected diseases in the Sudan is described and discussed.

**Keywords:** Citrus diseases, Sudan

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## **Studies on Vaccination Trials Against Morel's Disease and Monitoring of Transfer of Passive Immunity from Dams to Lambs**

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This becomes the first report of vaccination against Morel's disease (sheep abscess disease) in the world. A trial of formaline killed bacterin of *S. aureus* subsp. *anaerobius* to protect young lambs against sheep abscess disease (Morel's disease) was carried out. Vaccination reduced the incidence of infection by approximately 65 % and the size of abscess was markedly reduced in lambs which acquired infection in spite of vaccination. Another trial using a formalinised killed whole culture, capsular antigen and toxoid produced 96.4 % protection was tried. Two doses of this vaccine prepared (the first dose was 1.0 ml and the second 0.5 ml) given two weeks apart, and then challenged one month later with 1200 organisms (three times the minimum abscess causing dose). This protection has been achieved both in experimental studies and field experiments against Morel's disease. The vaccine gave protective responses detected by prevention of abscess formation in challenged lambs. Monitoring of Passive Immunity Transfer from pregnant vaccinated ewes (against Morel's disease) to their lambs The passive immunity transfer from pregnant ewes to their lambs was monitored from birth to seventh months of age in those born from vaccinated ewes against Morel's disease and others born from non-vaccinated ewes. The vaccination of ewes before lambing provided passive protection to lambs during the first 20 weeks of age. Usually the site reaction after vaccination appears first as oedematous area that enlarges and reaches the maximum site reaction; then hardened and start to regress till disappear, leaving no scar and forming no abscess. The vaccination against Morel's disease did not cause abortion nor it affected the conception rate.

**Keywords:** Abscess, lambs, sheep, *Staphylococcus*, vaccination

## Strategies for the Management of Mycotoxins in Maize in Benin, West Africa

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According to the FAO, 25 % of the world's food crops are affected by mycotoxin, which negatively impact human health, food trade, food availability and consumption. People are primarily exposed to aflatoxin through consumption of contaminated foods. It was shown that 99 % of children monitored in Benin and Togo had high aflatoxin levels in the blood, with some of the highest AF-alb levels ever measured in children. The study showed a striking association between aflatoxin exposure and impaired growth. Depending on ecozone and season, up to 57 % of stored maize samples were contaminated with aflatoxins. Aflatoxin contamination is influenced by the populations of toxin producing fungi that reside in the soil, cob feeding lepidopteran insects, invading weevils and other beetles; cultural management of the crop, environment and plant stress; and genotype.

In participatory trials in Benin and Togo, crop and store management options were developed to reduce mycotoxin contamination of maize and their economic viability was assessed. Drying and sorting of maize are techniques that can reduce aflatoxin contamination in maize. Similar technologies have been identified for fumonisin contamination in Benin. The study showed that *F. verticillioides* was the predominant *Fusarium* species found in all maize samples. *Fusarium* incidence was significantly higher when maize was stored on a cemented floor in a house ( $40.3 \pm 17.4\%$ ) than in the other systems. The lowest *Fusarium* incidence was recorded when maize was stored in a bamboo granary ( $25.5 \pm 13.5\%$ ) ( $p = 0.04$ ). This suggests that storage systems used by farmers may affect *Fusarium* and *Aspergillus* infection on maize, if these systems create conditions favourable to fungal growth. Damage by lepidopterous pests was significantly and positively correlated with both *Fusarium* infection ( $r = 0.802$ ,  $p < 0.01$ ) and fumonisin contamination ( $r = 0.852$ ,  $p < 0.01$ ). Insect damage was positively correlated to aflatoxin content ( $r = 0.20$ ,  $p < 0.01$ ).

The control of mycotoxigenic fungi with management practices easily accessible and affordable to farmers' will lower the risk that mycotoxins pose to human health and improve health and human well being.

**Keywords:** Aflatoxin, food quality, fumonisin, management

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## Aflatoxin Risk Assessment, Biological Control Options and Intervention

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Aflatoxins are toxic compounds produced by the fungus *Aspergillus flavus* which infects corn. It thrives in warm and humid areas of tropical Africa where corn is grown and stored. Aflatoxins are mutagenic, carcinogenic, teratogenic and acutely toxic to animals and humans. It is known to cause liver cancer. Their chronic and long-term effects on humans exposed to low doses over time are not well understood.

Earlier studies by researchers from IITA and the University of Leeds showed a strong association between blood aflatoxin levels and stunted growth in young West African children. Stored grain in the studied areas often had much higher levels of aflatoxin than the currently accepted safe limit of 20 ppb. As a result, 99% of the children examined in these areas had aflatoxin in their blood.

A new research project, funded by the German Development Agency (BMZ), will exploit an innovative biological control strategy called “Competitive Exclusion” to minimise the contamination of crops by aflatoxin. The goal is to introduce and establish an atoxigenic strain that does not produce any toxins in order to replace the strains of *Aspergillus flavus* that cause contamination of the food basket with aflatoxin. Potentially atoxigenic strains of *Aspergillus flavus* have been isolated in various regions of West Africa. The atoxigenic nature of these isolates is presently being investigated at the Institute for Plant Diseases, University of Bonn. The capability to produce aflatoxin in liquid fermentation will be evaluated by using TLC. In addition, vegetative compatibility group (VCG) testing has been initiated with these isolates to determine relative natural dominance, competitive displacement, survival, dispersal and safety issues.

**Keywords:** Aflatoxin, *Aspergillus flavus*, atoxigenic

## **Governance and Biodiversity — Linking Conservation Success with Management Perspectives — The Case of Biosphere Reserves**

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Losses in biodiversity are becoming alarming: currently about 50 known species per day are irreversibly lost. Especially from a global perspective nature conservation should be a goal in its own right. This means placing priority on the protection of species and habitats. However, scientists, managers and local people are debating intensively on how to combine biodiversity conservation with the need for local development. The latter is becoming increasingly critical as most Biodiversity Hotspots are located in Third World countries.

An innovative approach to biodiversity management are Biosphere Reserves which comprise a strategy to reconcile conservation objectives with the sustainable use of natural resources. In that way they aim to be experimental places for integrated conservation efforts, and vanguards for sustainable development. The conservation success of Biosphere Reserves and other protected areas depends on the appropriateness of their management systems to the locally specific situation as well as on governance issues, i.e. the political and administrative system, resource-use patterns and participation of local people. In practice many Biosphere Reserves lack capacity and resources to meet their global mandate.

Our interdisciplinary research group examines the effectiveness of management and governance approaches in achieving integrated conservation and development objectives, combining ecological and socio-economic concepts and methods in an adaptive manner. Using a broad range of qualitative and quantitative research methods we develop and test a set of criteria and indicators to identify how particular factors influence success or failure of management and conservation in Biosphere Reserves. The co-evolution of the management success model and the conservation success model will allow the development of a comprehensive analytical tool for determining the success or failure of Biosphere Reserves. In addition, the broad empirical results will justify a series of recommendations for more effective approaches to nature conservation.

**Keywords:** Biodiversity conservation, Biosphere reserves, governance, Integrated development approaches, interdisciplinary research, management

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## Phasing Out Development Interventions — Challenges and Opportunities for Participation

KARIM SAHYOUN

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Self-sustaining development, lasting impact, empowerment is what development actors aim for. But at the end of a development intervention many find themselves worrying that everything will collapse and much effort has been in vain. Local beneficiaries and intermediary organisations experience phase out as a shock and surprise. Some even express feelings of betrayal. Decisions on phase out are usually taken by the donor and are little participatory. Development interventions naturally create dependencies since roles and responsibilities are taken over by outside actors and resources are provided. Consequently developing effective strategies enabling phase out is not only prerequisite to achieve empowerment and avoid long-term aid dependency. It will determine an intervention's overall sustainability and effectiveness as well as the efficient use of limited resources, and attitudes towards future development interventions. Having these facts in mind, and the many failures attributed by development practitioners to the ending of external support, it is striking that phasing out is one of the least understood and documented aspects of development. This research is based on a participatory action research approach with case studies in Kenya and Tanzania involving participatory community development programs. To enable phase out the two dimensions of aid dependency, the physical and psychological, need to be addressed. Physical dependency is created when development programs rely on outside capacities that cannot be built locally or when no or ineffective strategies are in place to build capacities and transfer responsibilities. Psychological dependency, often described as dependency syndrome, is caused by beliefs and attitudes held by outsiders and locals, that the target group is not able or willing to take over. Psychological dependency needs to be addressed right from the initial stage to change negative perceptions about phase out. This is precondition for a participatory programme design process which from the beginning considers what responsibilities should be taken over by outsiders and develops realistic strategies for transfer. Continuous monitoring allows adapting the strategies. Development practices that encourage strengthening capacities and building on local resources are appreciative approaches, participation, training of local facilitators and trainers, building external linkages and cluster level organisations, cost sharing, advocacy.

**Keywords:** Dependency, phase out, programme planning, project management

## **Foreign Aided Projects and Rural Livelihoods. Analysis of Impact of Project Intervention on Production Efficiency — A Case of Livestock Development Project in the Mid Hill Region, Nepal**

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The agricultural sector is still the backbone and major source of livelihood for 81 % rural inhabitants in Nepal. It contributes 39 % to the GDP. The livestock sector is an indispensable component to sustain agricultural system, which contributes 31 % to agricultural and 18 % to national GDP. The upward trend of livestock contribution to the economy has widened possibilities for future investment, gender balanced development, and rural employment. This sector, however, has acute resource constraints since the overwhelming majority of the pastoralists are resource poor producers.

The government endeavor to increase the livestock productivity has been assisted by multinational donors. The amount of external assistance in livestock component has been in excess of US\$ 247 million over the past 20 years. To find out the impacts of such donor assisted projects at household level, specifically on farmers' efficiency on resource allocation and production optimization of livestock enterprises, is the major objective of this paper.

A with and without project evaluation approach was applied as a research methodology to test the hypothesis that efficiency of project intervened farmers would be higher. A household survey was conducted to collect primary data applying multi-stage random sampling procedure for 165 households. The collected cross sectional data was processed and analyzed using descriptive statistics, econometric models of COBB-DOUGLAS and Translog types Stochastic yield functions and qualitative analysis.

The hypothesis is partially proven. Of the four commodities analyzed, the mean technical efficiencies for producing goat meat, cow milk and egg are found higher with treatment group (64 %, 48 % and 82 % respectively) than that of control group (56 %, 43 % and 70 % respectively). Unlike these three commodities, converse result is obtained in case of buffalo milk production.

Therefore, mitigating factors causing low level of technical efficiency as revealed by econometric results would help make farmers more efficient in order to increase the overall production efficiency of livestock enterprises and thereby improve livelihood of the rural inhabitants who are primarily involved in livestock farming.

**Keywords:** Project intervention, livestock commodities, rural households, impact on efficiency

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## Research and Development in Smallholder Sericulture for Rural Poverty Reduction in Java, Indonesia

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Java is one of the most densely populated regions in the world at 1000 persons per km<sup>2</sup>. The per capita income in the rural areas is estimated at US\$ 500. GEERTZ, already in 1969 had coined the term involution for the island of Java implying that additional labour could no longer be usefully employed in agriculture and that population growth could only lead to increasing poverty in the rural areas. A policy response has been the “*trasmigrasi*” programs encouraging people to move to other islands of the Indonesian archipel. An autonomous response has been land flight or the uncontrolled movement of people to the already overcrowded cities or rather the slums thereof.

Efforts continue to be made to increase the income potential of rural households through the use of resources with low opportunity costs. In recent years sericulture has gained attention; mulberry shrubs can be grown on hilly land and labour not needed for crop production can be effectively utilised. cursory calculations show that rural incomes could be doubled through the addition of sericulture activities. However, the introduction of sericulture in rural areas requires the establishment of a very complex project structure raising different practical problems and research questions at every project phase.

The basic contention of the paper is that — in the case of very complex projects — it is not the project but rather the project cycle that should provide the framework for analysis. The different phases normally recognised are conceptualisation, feasibility studies, appraisal, finance proposals, implementation, monitoring, evaluation and feedback with the policy environment. Taking them one by one for a concrete project case they provide insights into the workings of a project over time. The spectre of issues and questions changes. Themes of research for development take on different importance as the passing of time is taken as one of the dimensions of a project. Conclusions about the effectiveness of a development project in reducing poverty become more realistic.

**Keywords:** Indonesia, rural poverty reduction, sericulture, smallholder

## Seasonal Vulnerability to Poverty and Indigenous Fruit Use in Zimbabwe

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Transient and chronic poverty are common problems in the rural areas of Sub Saharan Africa. Rural households frequently rely on indigenous fruits (IF) and other wild food resources during times of food and income shortages in order to supplement their incomes. However, the degree to which indigenous fruits contribute towards rural incomes and thus the reduction of poverty and vulnerability to poverty has previously not been assessed due to a lack of quantitative data.

This paper assesses the contribution of indigenous fruit trees towards reduction of vulnerability to poverty by taking seasonal fluctuations of the income and expenditure flows and fruit availability into account. Monthly income and expenditure data over all income generating activities from a sample of 20 households from Takawira resettlement area, Zimbabwe, is used to model the stochastic household income in the course of the year.

Results show that vulnerability to income poverty is very high amongst rural households and is subject to seasonal fluctuations. Vulnerability is highest during the critical period of the year, i.e. between August and January when IF are available. The surplus that was carried over from the previous cropping season and also on the degree to which indigenous fruits are used/ are available for income smoothing determine vulnerability to poverty. As expected, the higher the availability of IF, the lower vulnerability to income poverty. Although indigenous fruits contribute towards reduction of vulnerability, other sources of income show higher influence on the household income. The highest influence stems from production of agricultural crops, which contribute a major share towards rural incomes. We conclude that collection of IF constitutes an income source that can easily be accessed in times of need in order to bridge income and food shortages but not a major source of income in the long run.

**Keywords:** Indigenous fruits, poverty, seasonal income fluctuations, vulnerability to poverty, Zimbabwe

## Popular Participation and Decentralisation — The Role of Social Actors in Reconfiguring Power Relations

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The processes of decentralisation in Latin America have intensified during the last 20 years as the means to deconstruct the centralist state and its administrative inefficiencies and concentration of power. Administrative management and economic resources distribution, often accompanied by strengthening of local democracies were carried out.

In Bolivia, the Administrative Decentralisation Law came along with the Popular Participation Law, being both part of a set of legal State reforms. Both are recognised as the most ambitious attempt in the region to include historically marginalised social groups on the national life.

Despite the wide acceptance of the laws all along the country and the first successful experiences in deepening democracy in Bolivia, “there is no evidence showing that rural municipalities have enlarged substantially either their own income or their local productive surrounding” (URIESTE, 2001:23). This can be explained by the many treats that are undermining the potential of the new laws to bring about better conditions for the population:

- The inefficiency of the application of the PPL and ADL on addressing people’s interests;
- The increasing set of regulations which undermines the empowering character of participation and;
- The predominance of old elites and social dynamics that perpetuate, now as before the laws, the uneven relations of power.

While these threats can be related to the local lack of experience in financial and technical handling of projects along with lack of coherence between Departmental and Municipal policies, they are more largely related to dominant socio-political interests driving to explicit and implicit exclusion of groups with less capacity to link development interventions into their own life worlds. That is, the formal and informal exclusion of groups because of the difference of knowledge of formal systems of participation, different forms of representation systems, less connection to urban centres and lack of economic and political means to influence decision-making processes.

This study has the objective to compare how local actors and organisations reconfigure power relations in highly and less socio-political differentiated municipalities, under the processes of popular participation and decentralisation.

**Keywords:** Decentralisation, local development, local power, popular participation

## Farm Forestry to Alleviate Poverty — Findings from Three Differently Developed Rural Economies in Central Laos

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The socio-economic development of largely subsistence-oriented rural areas is a prominent policy objective in Laos. Whereas in the surrounds of major urban centres and regions with favourable infrastructure and market access a dynamic industrial and service sector have emerged, most of the countryside remains economically undeveloped.

Cultivation of commercial tree species is acknowledged as a successful option to diversify farm production, to generate supplementary financial income and thus to include rural populations into the market economy. The Government of Laos promotes private afforestation through allocation of permanent use rights of degraded forestlands to individual households, as well as the recognition of private ownership of the plantations.

The study analyses socio-economic prerequisites for and obstacles of farm forest establishment at individual farm-household level employing the Farming Systems Research Approach. Three villages that differ with regard to their socio-economic development and that represent semi-subsistent, semi-commercialised and fully commercialised economic contexts, respectively, were investigated.

The explorative field research followed a specifically elaborated mix of methods. Empirical social research tools such as interviews and observation were conducted to collect primary data sets of 73 peasant households.

The study revealed that farm forest establishment largely is determined by customary land claims. Households that are traditionally deprived of access to land resources benefit from farm forestry in circumstances only of abundant, yet unclaimed land reserve.

Under semi-subsistent conditions, farm forestry plots are mainly established by well-off households that have a minimum level of land, labour and capital resources at their disposal. In the commercialised village, tree planters typically belong to the medium population stratum, whereas well-off households primarily derive their livelihood from profitable off-farm employment and less from farm activities. In general, farm forestry failed to address the needs of the poorest households.

**Keywords:** Private afforestation, resource access, rural development

## **Date Palm (*Phoenix Dactylifera* L.) — A Potential Food Security in the Kingdom of Saudi Arabia — Research and Development**

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Date palm (*Phoenix dactylifera* L.) is the major fruit crop in the Kingdom of Saudi Arabia covering approximately 72 % of the total area under permanent crops. The estimated number of date palm trees in the Kingdom is 18 million. About 65 % are bearing trees with an annual production of 700,000 tons. More than 400 different date palm cultivars are estimated to exist in Saudi Arabia. Date palm is a multi-purpose tree, being highly estimated as a well-reputed national heritage to the Saudi population. It provides food, shelter, timber products and all parts of the palm can be used in many different ways. Due to its importance in peoples daily life and its tolerance to the harsh environmental desert conditions, areas under cultivation have tremendously increased over the past few years. Despite the fact that only 6 % of the total fruit production is exported, growers and investors are looking forward to opportunities to enter the international markets. Improvement of marketing and export efficiency for date palm growers is a high priority aspect for both public and private sectors.

This paper briefly reviews the agronomical and economical facts of date palm production in the Kingdom of Saudi Arabia. It also reflects past and current scientific efforts to improve this important sector, in addition to possible constrains that may hamper the further development of date production. Scientific programmes for improving date palm cultivation and production have covered a wide range of activities in the field of biotechnology, physiological and phytosanitary aspects, postharvest handling, processing and marketing.

A joint project on date palm stress physiology of Humboldt University of Berlin, the National Date Palm Research Center and King Faisal University in Alhassa will be introduced.

**Keywords:** Date palm, research, Saudi Arabia

## The Impact of Poverty on Natural Resources — Is There a Future for Working Elephants in Burmese Silviculture?

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Timber extraction with elephants is an old tradition in Burmese silviculture and still today, the majority of timber in Myanmar (Burma) is dragged by about 3,000 working elephants (MTE, 2001). Climatic and topographical conditions impede the operation of machines. Besides, timber extraction has to meet the regulations of the Myanmar Selection System (MSS) which includes sustainable forest management. The damage of soil and remaining stands by elephants may be less compared to machines. Therefore extraction is not possible without elephants according to Burmese foresters and veterinarians. Consequently elephants could play an important role in sustainable forest management also in future.

- But what about the conditions under which people and elephants live and work?
- Do they meet modern ideas of working conditions and animal husbandry?
- How are the relations between human beings, elephants and the natural resources?
- What conflicts exist and might show up in Burmese timber extraction in future?

Cruel elephant taming and training methods does not meet the requirements of international animal welfare organisations. Low education and salaries for the workers and their families lead to high pressure on natural resources like forests, rivers and the local fauna. So elephants, wild living (about 4,000 in Burma, MARTIN & VIGNE, 1997) as well as tamed ones, enter into competition about natural resources with the human population, which causes many conflicts. Elephant habitats are shrinking due to agricultural expansion, natural fodder is scarce and wild living elephants are destroying fields by feeding on agricultural products.

If this tradition can be still maintained in future, depends on solutions for diverse conflicts. More investigations on natural elephant habitats and fodder are required, elephant taming and training methods should be modified and the situation of workers and their families in the elephant camps should be improved, which means poverty reduction and development of rural areas. A great task which is not easy to settle and can take a long time — maybe too long!

**Keywords:** Extraction, Myanmar (Burma), natural resources, poverty, working elephants

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## **Indigenous Local Identity on Managing Natural Resources in a Typical Rural Area of the Amazon Marginal Zone — The Case of Jave Indigenous Peoples in Bananal Island, Tocantins**

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The rainforest zone in Brazil is under pressure through encroachment of farming and other sectors leading to an ecologically unbalanced development, reducing the living potential of indigenous peoples. In some regions, the Brazilian Government has taken actions to prevent this problem. The objective of the study is to understand and explain the dynamics of development of the indigenous communities in the forest and the different farming systems of the borders. The study area is the Bananal Island along the Javae River in Tocantins State, Brazil. The socio-economic analysis was conducted based on the Farming System Approach. Since 1996 all non-indigenous population was removed from the demarcated Indigenous Land. The research confirmed that the economic activities of the indigenous populations bring cash to the society, improving some sectors of their living. Recently schools and health services have been implemented by a local NGO and the Government. Although no correlation between the education level of indigenous peoples and their income could yet be found, an improvement on it can provide a good basis for effective communication, better understanding the actions and intentions of external people in contact with them. The low population density of this Indigenous Land is a sound basis for sustainable development. The problem rises when outsider fishermen or farmer /rancher enter the area without an effective control of their actions. In comparison with smallholder of Loroty Settlement — the poor people removed from the Island — the indigenous families reached a similar income level. In a partial analysis of farm system the differences become visible as smallholders base their economies on farm activities while indigenous peoples; on fishery and forestry extraction. It can be concluded, that there is a potential for development for the indigenous people after their areas have been protected. For the settlements, they must be guaranteed their socio-economic development to avoid future encroachment in the Island and competition for natural resources. This can be implemented through credits schemes. Large-scale farming is extremely profitable and is sharply contrasting to the other groups. This group can be seen as potential in absorbing labour-force for their large-scale productions.

**Keywords:** Farming systems, indigenous local knowledge systems, rainforests

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## Effects of a Rural Poverty Alleviation Project on Production System and Farming Income in a Semi-arid “Secano” Area

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The study was carried out in the Secano Coastal, a coast dry land of Central Chile (Curepto, VII Region) in October and November 2003. It used an ex-post fact investigation design with a historic control group (*reflexive comparison*). The target population was small farmers, who participated in the poverty alleviation project Prodecop-Secano (carried out 1997 to 2003 in the micro-region Curepto). The sample consists of 90 small farmers, selected from 11 localities (classified as Low, Middle and High altitude locations). The data were sampled by face-to-face interviews.

Mainly, the study investigates if the on-farm income of participating households increased by the comparison of gross margins. The study also examined participation effects on the production system of the farmers. As well, the adoption of more sustainable resource conserving agricultural practices in the face of drought and erosion risks which constituted an additional aim of Prodecop-Secano. We explored risk perception and coping strategies with Lickert-type attitude scales and open questions.

Land availability and land tenure did not change since the start of the project. The farm capital increased, mainly because the facilities improved (durable assets). The production system showed some changes as the farmers introduced more labour intensive crops, such as fruit trees and vegetables. Also, some small forest plantations were added. There was no significant improvement on-farm income of the farmers (at the total sample) between before and after the project intervention. As well, there was no unanimous trend in on-farm income among areas. In the Low land-area income decreased while in Middle and High land-area it increased. The variability of on-farm income also increased strongly. The farmers fear environmental risks—particularly severe droughts—more strongly than economic risks. The adoption of resource conserving agricultural practices— including terraces, better irrigation techniques— was highly variable and it found high percentage of farmers that stop the use of these practices.

**Keywords:** Adoption, dry land, gross margin, income, poverty, risk

## Adoption of Indigenous Fruit Tree Planting in Malawi and Zimbabwe — An Ex Ante Assessment

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The domestication programme of indigenous fruit trees (IFT) of the World Agroforestry Centre (ICRAF) aims to increase farm-household income via farmer-led tree planting of domesticated indigenous fruit trees. Improvements of the domestication programme target at reducing age at maturity and increasing fruit yield and quality. Farmers so far rarely plant the IFT but rather collect IFT products from the commons. Previous research in Zimbabwe shows that trees have to be improved significantly to render farmer-led tree planting economical. In other Southern African countries, e.g. in Malawi, economic conditions as well as availability of IFT products from the commons differ and thus the adoption potential for indigenous fruit tree planting may also differ.

The paper aims at assessing the technology adoption potential of planting domesticated indigenous fruit trees in Malawi from an ex ante perspective. By applying a real options approach uncertainty and irreversibility over benefits related to investment are taken into account and the value of waiting to invest is determined. Similar to previous research in Zimbabwe, contingent claims analysis and the capital asset pricing model are applied in order to determine the risk adjusted rate of return under Malawian conditions. To this purpose, the different sources of farm-household income are used to set-up the rural household portfolio. Our analysis investigates (i) to what level fruit collection cost have to rise, (ii) the necessary technical change, i.e. breeding progress, and/or (iii) price increase of domesticated indigenous fruit that will render tree planting economical in Malawi. Finally, results on the adoption potential of IFT in Malawi are compared to findings on the adoption potential of IFT planting in Zimbabwe, factors that explain the difference are identified and recommendations for the domestication programme are given.

**Keywords:** Ex ante impact assessment, indigenous fruits, Malawi, real option, technology adoption, Zimbabwe

## Development Possibilities for Farms in Tschuwaschia, Russian Federation

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The situation of agricultural farms in the region of Tschuwaschia (Russia) is characterised by suboptimal production conditions, which lead to an unprofitable income situation, worsening of machinery equipment, bad staff motivation, lack of capital and increased debts. As an outcome of this development production decreased continuously in the last years. The demands of the population towards food could not be completely satisfied any longer.

The objective of the presented study is to analyse which obstacles and potentials for development exist in the region and which development and intensification potentials exist to increase productivity.

For the study a big agricultural cooperative willing to cooperate was chosen.. Primary data were collected by intensive interviews of the manager of the farm as well as by own data collection to create the demanded data base. Book keeping data were one of the major sources for secondary data collection. Additionally data of the ministry of Agriculture of the Republic of Tschuwaschia were used for the study.

For the analyses spread sheet calculations (Excel/Microsoft) as well as programs to calculate farm development plans and tools to define optimising enterprise strategies (MAX Ströbel, H. et al, FH-Weihenstephan) were used.

Cereal production was identified as major problem for profitability. The natural conditions allow relatively high yields, if soil preparation and cropping technology is adapted to the conditions. The yield level reached so far in the agricultural enterprises was only about 50 % of the possible yield. The analyses showed, that bottlenecks exist for the use of means of production. The demanded increase in productivity can be reached by improvement of the use of means of production, such as seed, adapted modern technology, adapted fertiliser and pesticides. The conducted optimising calculations suggested, that the net profitability of the enterprise can be increased by three, if the improved use of means of productions is done. The investments also need to a highly increased cost-effectiveness of own capital (by 22,65 %, interest rate 7 %).

The analyses proofed that investments in farms in the region can be profitable and lead to highly improved income situation as well as to an improved food supply.

**Keywords:** Farm development, food supply, Russian Federation, Tschuwaschia

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## Sustainable Agriculture and Precision Farming in Developing Countries

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Sustainable agriculture in the context of development efforts has to meet production efficiency, sensitivity of ecosystems, appropriate technology, maintenance of the environment, cultural diversity and satisfaction of the basic needs. The green revolution increased significantly the productivity in developing countries, but it had also several negative ecological consequences such as depletion of lands, decline soil fertility, soil salinisation, soil erosion, deterioration of environment, health hazards, poor sustainability of agricultural lands and degradation of biodiversity. Today agricultural research seeks new management strategies and technologies to reorient the current and future needs and constraints. The new options should be productive and cost-effective, but furthermore must be particularly ecologically sustainable.

Precision Farming identifies the critical factors in production systems by determining the limiting and controllable components. The components often decrease yields and system efficiency because of their spatial variability. The variations occurring in crop or soil properties within a field are noted or measured and mapped. Management actions within PF are then taken as a consequence of this assessment of the spatial variability within that field. Development of geomatics technology in the later part of the 20<sup>th</sup> century has aided in the adoption of site-specific management systems using remote sensing, global positioning systems and geographical information system. This approach is also called sitespecific management. Sitespecific management of spatial variability of a farm is developed to optimise crop production and to minimise environmental pollution and degradation, leading to a more sustainable development in general. In the present context, maintenance of ecological balances through precise and site-specific management is highly desirable. The concept of Precision Farming may be appropriate to solve these problems, though it looks unsuitable to many local conditions. Agriculture in developing countries is often characterised by low usage and support for technologies. Precision Farming being a management approach not just a technology can equally be applied to developing countries as well as developed countries, but the implementation is different. If technology is needed they should be used to complement the traditional methods for enhancing productivity and quality, rather than to replace the local conventional methods.

**Keywords:** Acceptance, Adaptation, site specific management, Sustainability

## Communities Classification as a Base for the Understanding of Dynamics of the Land Use in Protected Forest Sumaco

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A series of publications make references to the problems about in the management of the Protected Forests in Ecuador. Nevertheless the literature totally limits itself to a general description of the situation without considering neither the real problems of the local population in these areas nor the state of conservation in the natural resources. It is necessary to mention, that National Parks and others Protected Areas becomes synonymous with the natural resources. It is necessary to mention, that National Parks and others Protected Areas becomes synonymous with “Paper Parks and Protected Areas” in many developing countries after it was noted that, conservation measures did not produce any visible impacts in the pristine forest. More importantly, for effective and efficient conservation of a Protected Forest systems, both realistic description on the local communities behavior and regional land use dynamics need to be taken into account. Furthermore, formulating of policy requires better knowledge of what the community actually do. The study below responds to this need by providing some descriptive insight into the land use patterns of the communities in the Protected Forest Sumaco. In order to incorporate the spatial information into analysis, topographic maps and tenancy map were digitalized into Geography Information System (GIS) to use as input layers. Then these maps and temporal satellite images from 1995, and 1997 were used in GIS analysis to get a deep insight into the temporal and spatial variations in the land use dynamics of the areas. In addition, Participative Rural Appraisal (PRA) methodology was employed with a sampling intensity of 38 %, which collected socioeconomic information of local communities and biophysical conditions of the local resources bases. Cluster Analysis was conducted with a view to aggregate the local communities, and Discriminate Analysis was also performed to identify the factors affecting the grouping of the communities of Protected Forest Sumaco. Finally, three strategies were proposed to address the problems for effective conservation of the Protected Forest and sustainable development of the area.

**Keywords:** Cluster analysis, discriminate analysis, GIS, neotropical forest, Ecuador



## Nutrient Cycling and Field-based Nutrient Balances in Mountain Oases of Northern Oman

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Little is known about nutrient fluxes as criteria to assess the sustainability of traditional irrigation agriculture in eastern Arabia. In this study GIS-based field research on terraced cropland and groves of date palm (*Phoenix dactylifera* L.) was conducted over two years in two mountain oases of northern Oman to determine their role as sinks for nitrogen (N), phosphorus (P) and potassium (K). At Balad Seet about 55 % of the 385 fields received annual inputs of 100–500 kg ha<sup>-1</sup>, 26 % of 500–1400 kg ha<sup>-1</sup> and 19 % that were left fallow did not receive any N. Phosphorus was applied annually at 1–90 kg ha<sup>-1</sup> on 46 % of the fields, whereas 27 % received 90–210 kg ha<sup>-1</sup>. 27 % of the fields received no K, while 32 % obtained 1–300 kg K ha<sup>-1</sup> and the remaining ones up to 1400 kg ha<sup>-1</sup>. At Maqta respective N-inputs were 61–277 kg ha<sup>-1</sup> in palm groves and 112–225 kg ha<sup>-1</sup> in wheat (*Triticum* sp.) fields, P inputs were 9–40 kg ha<sup>-1</sup> and 14–29 kg ha<sup>-1</sup>, and K inputs 98–421 kg ha<sup>-1</sup> and 113–227 kg ha<sup>-1</sup>. For cropland, partial oasis balances (comprising inputs of manure, mineral fertilizers, N<sub>2</sub>-fixation, irrigation water and outputs of harvested products) were with surpluses of 139 kg N, 41 kg P and 99 kg K in Balad Seet (totalling 4.6 ha) and of 135 kg N, 16 kg P and 57 kg K ha<sup>-1</sup> in Maqta (0.4 ha) similar. This was despite the fact that N<sub>2</sub>-fixation by alfalfa (*Medicago sativa* L.), estimated at 480 kg ha<sup>-1</sup> yr<sup>-1</sup> with an average total dry matter of 22 t ha<sup>-1</sup> contributed to the cropland N-balance only at the former site. Respective palm groves balances, in contrast, were with 313 kg N, 43 kg P and 191 kg K ha<sup>-1</sup> (on 8.8 ha) and 83 kg N, 14 kg P and 85 kg K ha<sup>-1</sup> (on 3.6 ha) remarkably different in both oases. This was mainly due to the recycling of nutrients in human faeces from the artificially high population at Balad Seet living largely on imported food.

**Keywords:** Animal manure, irrigation agriculture, N<sub>2</sub>-fixation, sustainability

## **Integrating Micro Level and Remote Sensing Data in GIS Analyses for Natural Resources Management and Socio-economic Development — A Case in Mountainous Watershed in Nepal**

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Poor socio-economic condition and resource degradation follow a certain spatial gradient leading to further resources degradation and socio-economic differentiation in watershed area. Watershed degradation in mountainous areas is often a core problem with serious implication for sustainable resource use and living standard of rural households. Achievement of watershed conservation and people livelihood simultaneously is not feasible with a single suitable strategy. But, a best option to address it is to divide watershed area into homogenous zones based on resource availability, utility potentials and the socio-economic situation. Then zone-based problem solving strategies can be tested in producing best possible recommendations for future.

This paper presents a methodological concept of integrating socio-economic assessment with biophysical environment with a GIS. Biophysical indicators were assessed using RS/GIS technology. Socio-economic conditions of the people were assessed based on a survey with in-depth interviews with randomly sampled families. Then these data were linked to the GIS by using each family's respective geographical positioning, and their spatial distributions were observed by interpolation. The zones were formed by integrating spatially significant socio-economic and biophysical indicators. Zone 1 characterises high level of resources degradation and low level of the living standard while that of Zone 3 features with low level of resources degradation and high level of the living standard. The Zone 2 stands for medium level of resources degradation and moderate living standard.

The results show differences in the long-term development of land use in the past following different gradient in the area. Forest resource degradation, soil losses were found to be directly correlated with the altitude and slope of the land. Similar trend was observed with spatial differentiation of living standard parameters including farm family income, food availability, dependency on resources, etc. There was direct negative correlation in between the distance from the road, market and the altitude, and the socio-economic status-e.g. family income, education level, crop production and selling. Hence it is concluded that integration of socio-economic data into the GIS system is an appropriate tool for zone delineation to formulate long-term problem solving strategies achieving both sustainable natural resource management and better livelihood simultaneously.

**Keywords:** Degradation, GIS, integration, land use change, Nepal, resource use, remote sensing, rural development, socio-economic situation, soil loss, watershed, zone

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## **Spatial Modelling of Land-use Patterns in Forest Frontier Areas — Theory and Empirical Assessment for Indonesia**

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We develop a spatially explicit land-use model for a forest frontier area in Indonesia. The objective of the study is to describe the socio-economic factors that influence land-use patterns. We aim at understanding farmers' decision-making process as to where they will cultivate which crops and clear forest. Such a micro-economic focus is crucial for understanding the ongoing human-induced land-use change process and is essential in the land-use change literature — that is dominated by natural scientists focusing on geophysical and agro-climatic processes.

The model is derived from the von Thunen-Ricardo land rent theory that describes land-use patterns as a result of variability in geophysical land attributes and differences in location and transport costs. However, this model is valid only under certain assumptions and is less suited to describe land-use patterns in forest frontier areas characterised by semi-subsistence agriculture and imperfect markets. We refine the model to account for the fact that agricultural prices and wages might be endogenously determined and households cannot be considered as profit maximising agents. The solution to the analytical model defines a spatially explicit multinomial logit model. We estimate the model correcting for endogeneity and spatial dependence and using satellite image interpretation, GIS data and village survey data.

The results demonstrate that differences in Ricardian land rent are important in determining spatial land-use patterns. However, we do not find evidence in support of the von Thunen idea that land-use patterns are determined by differences in transport costs. Rather the labour intensity of land-use systems, population levels and household characteristics matter. Contrarily to other studies combining GIS and socio-economic data, we do find significant effects of socio-economic factors. This might be imputed to the unique combination of spatially disaggregated data with village survey data, instead of using aggregate socio-economic data that obscure causal effects. Further, the refinement of the von THUNEN-RICARDO land rent model is justified by the empirical results and might be a first step in the direction of incorporating more realistic descriptions of economic behaviour into spatial land-use models.

**Keywords:** Deforestation, Indonesia, land-use change, spatial models

## **Developing Integrated Resources Management System in the Middle Mountains of Nepal — A Case of Galaudu Watershed, Dhading District, Central Nepal**

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Agriculture is the mainstay of Nepal's economy as it generates about 56 % of the country's GDP and provides employment to 93 % of the labour force. People, land and water are the major resources of Nepal. Varied topography and geographical locations reflects opportunities and constraints, illustrating the diversity and complexity of the farming system. Dominant farming system varies with physiographic regions. Farming system in the mountainous, is mixed subsistence and heavily dependent on forest resources. However, Nepal's forests are declining in both quantity and quality continuously over the years and the imbalance so produced is posing a threat to the sustainability of agriculture-based subsistence economy. Hence integrating forestry with agriculture had become utmost necessity, as sustainable development is to link the conservation of the natural resources with the perceived development needs of the people.

This poster presents a methodological concept of integrating socio-economic assessment with biophysical environment with a GIS. Biophysical indicators were assessed using RS /GIS technology. Socio-economic conditions of the people were assessed based on a survey with in-depth interviews with randomly sampled families. Then these data were linked to the GIS by using each family's respective geographical positioning, and their spatial distributions were observed by interpolation.

Current results show differences in the long-term development of land use in the past following different gradient in the area. Forest resource degradation, soil losses were found to be directly correlated with the altitude and slope of the land. Similar trend was observed with spatial differentiation of living standard parameters including farm family income, food availability, dependency on resources, etc. There was direct negative correlation in between the distance from the road, market and the altitude, and the socio-economic status— e.g. family income, education level, crop production and selling. Hence it is concluded that integration of socio-economic data into the GIS system is an appropriate tool to formulate long-term problem solving strategies achieving both sustainable natural resource management and better livelihood simultaneously.

**Keywords:** Degradation, land use change, resource use, remote sensing, rural development, socio-economic situation, soil loss, watershed

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## **Reconstructing Patterns in Fire Regimes from Fire-scar in Mixed Pine-Oak Forest, Northeast Mexico**

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Wildfire is a prevalent natural disturbance in most of the world's forest ecosystems, (FALL, 1998, AGEE, 1991). Recently, scientists and forest managers have recognised the important role, fire plays in regulating forest ecosystems and maintenance of biodiversity. The effects of intense wildfires are a critical question in Mexico in respect to the year 1998, in which over 14,000 fires burned approximately 160,000 ha of temperate and tropical forests, and 425,000 ha of other vegetation types (SEMERNAP 1998).

In the case of Mexico, fire is a frequent phenomenon in many ecosystems and especially in protected areas such as national parks and biosphere reserves, where humans not influence natural processes. Fire in protected areas seems for many people as a controversial issue. Fire history reconstruction and also fire effects have been little studied in these ecosystems, therefore this research aims to reconstruct the actual status of forest fire history patterns and fire return intervals in mixed pine-oak forest in the Parque Ecológico Chipinque (PECH), Sierra Madre Oriental, Nuevo León in Mexico.

The historical frequency of fire in forests is computed by using the Mean Fire Return Interval (MFI). A chronosequence of natural fires occurring during more than 140 years has been reconstructed for PECH's forest by dendrochronology (determination of fire scars in annual rings of living trees). In the period from 1860 to 1998, five fire dates have been determined in 1624 ha area of PECH. Fire samples were taken from living trees and as well from stumps of the species *Pinus pseudostrobus* and *Pinus teocote*, exhibiting fire history evidence. All this contributions trying to define fire management strategies oriented to improve ecological conservation and sustainable forest management in Mexico.

**Keywords:** Fire ecology, fire history, Mean Fire Return Interval

## GIS and Farming System Analysis

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Rural project analysis demands a precise local socio-economic and agro-ecological assessment for extended regions. GIS allows combining local data with remote sensing for agro-ecological land-use modelling over broad areas. Farm system analysis supplies socioeconomic indicators at local and at regional level. Local data is included as quantitative and qualitative constraint. Joining both sources in a spatial database enables to spatially model the farming system. Quantification is possible of both, the socio-economic performance of the individual farming unit as a component of a farming system as well as its reciprocal influence with the natural environment. In the present case study the socioeconomic and ecological performance of a farming system is evaluated for the Guacurari District in Misiones, Northern Argentina. The Guacurari District delimitates a variegated environment of tropical forest, alternating with mate-tea plantations, livestock fields and annual crops. The farming units present an average size of 50 ha, ranging from 5 ha to 300 ha. Spatial analysis shows that only the largest farms, cattle producers, represent a homogeneous physical environment. The spatial distribution of the individual farming units shows that middle-size farms are located on the most suitable soils. There is no distinction per classes in respect to the distance to the urban centres. Smaller units are concentrated along the main roads. Rural schools are distributed evenly in the district, from which follows that 60 % are accessible mainly for the middle to larger units. The agricultural area averages 50 % of the available farming area; for the smallest units this figure is only 10 %. Extensive lines of production, mate-tea and cattle, provide the highest total agricultural income. In coincidence with this result, total farm income is closely related to agricultural area. Per hectare profit is higher in intermediate classes, with higher incidence of intensive land use activities. GIS-Farming system analysis is able to characterise a region down to the level of the individual farming unit. The natural environment and its interaction with the farming units is spatially quantified. Farmland use is precisely characterised at the field level. The livelihood of rural population is accurately evaluated through socioeconomic indicators.

**Keywords:** Annual crop, Argentina, farm income, farming area, farming system analysis, GIS, gross margin, Guacurari District

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## Simulating Spatial Patterns of Land-use and Land-cover Change — A Multi-agent Model and its Application to an Upland Watershed in Central Vietnam

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Land-use and land-cover (LUCC) is an essential environmental issue to be monitored and projected in order to suggest alternatives for better land management policy. However, scenario studies on LUCC processes are often challenged by the complexity nature and unexpected behaviour of these processes. The primary objective of this study is to formulate a spatial simulation framework of LUCC that can be used as decision-support tools in land management and planning.

This paper presents a multi-agent-based model for simulating the evolution of an entire rural landscape from local actor-based processes over an extended period of time, subject to different land-use policy options. Agents simulated in the model are households situating in defined typical household groups. A hybrid of spatial discrete choice function and rule-based computational method is employed to represent individual agent's behaviour about land and forest uses. Spatial entities in the model include land parcels (cells), micro-landscapes inferred by individual agents (agent's cellular grids), and the overall landscape (entire cellular grids). Cellular automata (CA), coupled with multi-nominal logistic computation of choice probability, are used to infer the knowledge needed by agents to make decisions about land use within their environment. The major innovation feature of this design is that performs human decision-making while utilises the strength of self-organisation concept in cellular automata simulation. Considered policy factors are land use zoning, forest use regulations and agricultural intensification level. As the model was designed using an object-oriented approach, it is extensible to other key policy factors.

The modelling framework is applied to a pilot model of a micro watershed of about 100 km<sup>2</sup> in a Luoi district, Central Vietnam. Spatially explicit data were obtained from Landsat ETM images, thematic maps, extensive forest inventory and intensive household survey. Field data were used for calibrating agent's parameters and develop an initial database for simulation runs. The relevance land use policy factors and related parameters were preliminarily checked with local key stakeholders. The model was built within NetLogo, an agent-based computer platform with user-friendly GIS interface and external controller.

**Keywords:** Agent decision-making, land use and land cover change, Multi nominal logistic model, Multi-agent system, NetLogo, Spatial simulation, Vietnam

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## Baseline Study to Implement an Integrated Pest Management Strategy for the Red Root Rot Disease at Sabah Tea Plantation, Malaysia

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Sabah Tea is the largest single commercial tea plantation in Sabah. Being certified by SKAL International, Netherlands Sabah Tea is one of the few tea plantations in the world to produce organic tea. Optimal yield production at Sabah tea is hampered by the presence of root diseases, the most common one being the white root rot. The causal agent of this disease is *Poria hypolateritia* a soil born pathogen. Although the red root rot is recognised to be the most destructive disease of tea particularly in Asia no sustainable control of the disease has been achieved so far. At present management strategies are solely based on sanitation, whereby infected tea trees with one or two rows of surrounding apparently healthy trees are uprooted and burned. Subsequent planting of Guatemala grass (*Tripsacum laxum*) interrupts the life cycle of *Poria* and allows for replanting after six to nine month. It appears that effective and sustainable management strategies to control red root rot are hampered mainly by a lack of understanding of the mechanisms of disease establishment and spread. This study was designed to collect baseline data on the behaviour and epidemiological characteristics of *Poria sp.* in order to develop and implement an effective integrated pest management strategy for the white root rot at Sabah Tea. Disease incidences were censused on a heavy infected field, whereby tea trees were visually characterised into healthy, infected and dead trees and geocoded. In addition geocoded soil samples were taken under healthy, infected, and dead trees and Guatemala grass. For each category three representable areas were selected on neighbouring fields, whereby for each area four subsoil samples were taken. Soil samples were analysed for pH, organic matter, and particle size and plant available nutrients. A DEM for the area, based on a 1:50000-scale topographic map updated with within field slope measurements was used to model the topography of the plantation. Information of spatial and temporal distribution of diseased tea trees, soil chemical parameters and topography were overlaid in a GIS environment to produce a risk map of the white root disease for the Sabah Tea Plantation.

**Keywords:** GIS, integrated pest management, local resource management, tea

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## **Guadua Bamboo (*Guadua angustifolia*) — Inventory in the Coffee Region of Colombia**

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*Guadua angustifolia*, a bamboo species with a high economic and conservation potential, has been studied intensively over the past years in Colombia. It is considered an alternative product for the farmers in the central region of Colombia, dominated traditionally by coffee-production.

Guadua "forests" are found along rivers and creeks and also in patches away from waters. Most of the Guadua stands in Colombia grow naturally. However, commercial cultivation has been increasing over the past years. Many questions arise about stand establishment, favourable site conditions, silvicultural treatment, technological properties of the culm etc. ?- and a basic information required for all resources planning and research is the estimation of the existing Guadua stands in terms of area and stand characteristics (like culm density).

In this paper, the results of an inventory of *Guadua angustifolia* in the Colombian Coffee Region are presented and discussed. This study had been implemented in 2002.

The area of Guadua stands (minimum area 0.3ha) was estimated from (available) aerial photographs. Systematic sampling was employed to collect field data, with a sample size of  $n=90$  on a  $10 \times 10$  km grid. Decision for the relatively low sample size was governed by restrictions of resources. The aerial photographs closest to the sample point were taken to center an aerial photo plot of approximately  $3 \text{ km} \times 3 \text{ km}$  on it. In these plots pure Guadua stands and mixed Guadua stands were delineated for area estimation.

For the field survey, 13 plots were randomly selected of the 90 interpreted aerial photos, excluding those without Guadua patches. In each field plot, 10 sub-plots of  $10 \times 10$  m each were randomly selected. There, number of stems, diameter  $d$  and other attributes were measured.

The results of the inventory are presented in this study.

**Keywords:** Bamboo, Coffee region, Colombia, forest inventory, *Guadua angustifolia*

## **Disaster Mitigation in Central America — An Approach for a Geographical Information System (GIS) on Georisks for Mitigation Planning and Risk Management**

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Central America is one of the regions most prone to disasters by natural hazards causing casualties on lives and infrastructure. A lot of data and information about geogene hazards have been generated in different projects in the region. Nevertheless, these piles of data still have to be compiled, analysed, assessed, and user-oriented processed in order to support planners and politicians in their decision making processes. Thus it would be possible to establish mitigation plans and policies. The implementation of these could help to reduce the vulnerability of the Central American population and infrastructure towards geohazards, allowing a more steady development.

Within the framework of the German Technical Cooperation, BGR, INETER and SNET are carrying out a project in Nicaragua and El Salvador on the implementation of Geographical Information Systems (GIS) on georisks. The objective is to integrate the mostly spatial generated data and information about geogene hazards and risks in order to analyse and interpret them to create useful information for decision making. To set up the GIS on georisks the project is being initially introduced on pilot areas, namely the Managua and the San Salvador areas. It is intended to extend the project to other Central American countries and to develop Central-American-wide information exchange mechanisms.

The specific challenge for establishing a GIS lies in developing an adequate structure and proper applications, where data input, data processing and the output of information is being defined. Moreover, a reliable and permanently updated data base has to be generated integrating the already existing ones. The process for analysing the data has to be settled as well as the query possibilities for users of different levels, in order to achieve user-oriented information on single and multiple geohazards and georisks.

The organisation of a user-oriented GIS on georisks is a long-term, iterative process. However, when the data sets are appropriate, GIS allows displaying thematic maps even during the early stages of GIS-projects, enabling the provision of maps on geohazards and georisks, as one of the many aims of the GIS. Those can then already be used for mitigation planning and risk management.

**Keywords:** Disaster, El Salvador, geohazard, georisk, GIS, mitigation planning, Nicaragua, risk management, user-oriented information

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## Subsession 2f: How to Maintain Regional Identity in Times of Globalisation

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## Food Security, Poverty Reduction and Gender the Debate on Food Security in Iran — Who Cares for Our Daily Meals?

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By translating the English word “food security” into the Persian Language it sounds like “Aminate Gazai”. This means “security of the meals”. There is no equivalent for “food” in the Persian language. Human beings don’t survive by food in the sense of raw products like rice, wheat, corn, barley, millet and others, but they live on prepared meals they eat on a daily basis.

Thus, “Aminate Ghazai” means more than food security. It can be seen in the context of food sovereignty with respect to the whole processes of production and preparation of meals and the rituals that come together with the serving and eating habits. If we concentrate our food security debates on a topic like “the security of daily meals” we will discover new dimensions that have been forgotten so far. This will give us a chance to rethink our concepts and analytical frameworks concerning human maintenance.

If we look at the security of daily meals new aspects become quite clear, like the work load, time and energy used for food production, knowledge about food products and their quality, different recipes and the harmonious mix of various stable crops and spices, that affects people’s health and well being. All these factors are part of the art to prepare the daily tasty meals.

In most of societies the preparation of daily meals are female tasks. Women in Iran decide what sort of meals should be cooked for invited guests. The way she select, taste, prepare, and organise all this is a complicated procedure of social interaction and gender relations. Human nutrition is deeply rooted in customs and beliefs present in everyday life. In this domain she has some familiar as well as political decision-making power, because most social interactions depend on the services and the hospitality that women offer. This should be reflected in the perception of food security as part of human maintenance. Thus, it is important to include the reflection on gender issues and power relations in private and public spheres as an important topic in the food security debate. Not food security or food policy, but engendered meal policy is the challenge for research and action.

**Keywords:** Cultural ecology, food security, gender, meal policy

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## **Food Security, Poverty Reduction and Gender a Key to Food Security in Africa**

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International research on food and gender issues should start from an actor oriented approach. This means the possibilities and constraints of local producers have to be taken into consideration. At the same time not all producers should be seen as a homogenous group. It should focus on power processes, gender hierarchies and generational conflicts which influence production systems and food security on household level. Two different case studies from West Africa and southern Africa will show how gender differences in the access to and control over food are interrelated with socio-economic and political power relations. In addition, cultural factors like the changes of food habits in the context of rural-urban migration are considered. A core issue is the importance of agro-ecological knowledge and resource management for food security. This paper will analyse factors and frameworks like the unequal access to land, information, technology and markets in rural African societies which hinder the use of local knowledge systems for food production and food security. In order to understand the complexity of the current situation historical dimensions like the colonial agricultural policies and post-colonial land reform programmes are taken into account.

**Keywords:** Gender and resource management

## **Food Security, Poverty Reduction and Gender Changes of Food Habits in Sudan**

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What is food? In biological terms human beings could eat all natural products which are not poisoned. But there are many differences between the various types of food people consume in different societies all over the world. In some societies specific types of food are eaten in other these particular food is taboo.

Thus food is more than its pure nutritional values in a biological sense. For human societies is it important to define the categories of eatable and avoidable food. Thus, cultural factors are not of less importance than biological considerations and the availability of food in general. Furthermore people don't eat natural products but meals which are prepared in a particular culturally accepted way. In addition, the eating habits are related to particular cultural norms.

Therefore, the preparation and eating of different meals are cultural performances. Food is directly related to culture and differs from society to society. We find differences not only in the so called eating cultures of different regions but at the same time in one society. Class, gender and age difference have to be taken into account. At the same time we find differences in one household when we look at the hierarchies of household members and gender roles. Even concepts and functions of kitchens and private spaces are influenced not only by ecological factors but furthermore by specific socio-cultural, economic, political and legal principles. Some of the relevant factors are: Access to resources, income, rules and regulations.

General statistics on food availability don't offer information about the real food situation, like the access to food of different regions, households and individuals, because these general statistics don't consider socio-cultural contexts. National food security does not only rely on the amount of food, but also on the purchasing power and capacities (like access to fuel wood, water, cooking utensils) to prepare meals out of raw products under the consideration of particular local socio-cultural concepts.

**Keywords:** Culture, food, gender, local knowledge

## The Making and Unmaking of Gendered Crops in Northern Ghana

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Based on fieldwork among the ethnic groups of Dagombas and Kusasis in

Northern Ghana, this analysis shows how the construction of gender and crop categories are intertwined and subject to negotiations. The linking concept between gendered responsibilities and access to the cultivation of crops is the ideological connotation entailed in who makes contributions to the proper meal. This consists of the categories staple and soup, which act as the blueprint for assigning crops to a specific gender. While men are responsible for providing millet or maize, they turn to onions and cowpeas as cash-crops in order to acquire the staple. Traditionally, certain taboos have ensured that staple crops would be a male domain, but this domain today remains male because of women's exclusion from access to technology. Women's local soup-ingredient, 'kpalago', which is made from the fruits of the 'dawadawa' or locust bean tree (*Parkia clappertoniana*), is slowly being substituted by soybeans. Among the Dagombas, the 'dawadawa' fruits symbolize the male power hierarchy. Their replacement by soybeans represents an encroachment of male territory, which has to be orchestrated in a clandestine manner. Furthermore, soybean cultivation is Dagomba women's gateway into own farming activities and for Kusasi women, it opens up viable economic activities. Thus we observe the making and unmaking of gendered crops, demonstrated by the case of the transforming staple and the transcending soup.

**Keywords:** Agricultural innovation, food preparation, local knowledge, gender





## Session 3: Technology Innovation

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## Improving Farmer's Livelihood in Rainfed Rice-based Lowlands of Asia

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About one billion people depend on rainfed rice grown on 50 million hectare in South and Southeast Asia. Farmers in these environments face various bio-physical stresses resulting in low and unstable yields (2.1 versus 5.8 t ha<sup>-1</sup> for irrigated systems in 1997–9) and are among the poorest in Asia. The most important abiotic constraints to production are regular droughts and unfavourable soil conditions (low soil fertility, toxicities).

Contrary to the developments in irrigated systems, successful introduction of modern rice varieties is rather recent in rainfed environments. Their main advantages are higher yields, better response to fertilisers, lower susceptibility to diseases, and shorter durations. Further varietal improvement for the adaptation to abiotic stresses can be expected through the use of recently discovered major quantitative trait loci (QTLs) combined with marker assisted selection tools. These developments offer considerable opportunities for a moderate intensification of rainfed systems, they can contribute to reduced production risk, and new possibilities for diversification are created. But to reach these goals, the variety-driven changes must be accompanied by improved/adapted crop and natural resource management options to maintain the productivity and sustainability of rainfed lowland systems.

Productivity increases will not only benefit the generally poor rainfed farmers, but could contribute an important share to the necessary rice production increases needed in the near future to compensate population growth rates and loss of prime farmland. Water use efficient and highly productive rice production technologies will become increasingly important in the near future due to a growing competition for available water resources and possible adverse weather conditions caused by global climate changes.

**Keywords:** Asia, Productivity, Rainfed lowlands, Rice, Risk reduction

## **Impact of Technology Innovation on Rice Yield Gap in Asia and West Africa — Technology Transfer Issues**

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This paper examines the impact of technology innovation on rice yield gap in Asia and West Africa countries. This is based on the premise that rice now accounts for the 22 percent of world's caloric intake and the significant role played in Asia Green revolution as well as the potential role in the expected Africa Green revolution. International, regional and national research organisations have collaborated research efforts in the last decade for increasing rice production, productivity and adaptation to marginal areas. Despite the volume of research and collaboration, the problem of wide gap between potential and actual yield persists. Yield gap has been attributed to biophysical, socioeconomic, institutional, policy and technology transfer and linkage factors. Reducing yield gap will increase rice productivity, improves land and labour use, reduces production costs and increases sustainability. Data collected on the technology transfer and linkage factors operationalised as the extension activities of Japan, Thailand, Nigeria and Ghana were regressed on rice yield gap from 1980–2002. The yield gap was determined as the difference between the potential yields and the actual yield. In some cases the gap was taken to be the difference between maximum attainable and the farm level yields. Important predictors of rice yield gap for each country were identified. These include extension agent, farmer ratio, extension funding, extension intensity, ratio of demonstration centre to farmers and the ratio of subject matter specialists to extension agents. These factors have implications for the appropriateness of technology to the farmers' environment and the effective transfer of technology and knowledge to the farmers. The paper concludes with pragmatic steps of how the identified factors can be incorporated into the sustainable increase of rice productivity.

**Keywords:** Asia, extension activities, farm-level yield., potential yield, rice, technology innovation, technology transfer, West Africa, yield gap

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## **Deterioration in Total Factor Productivity in Food Production in the Post Reform Period — The case in TEF in Ethiopia**

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Production and consumption of Tef as human food is peculiar to Ethiopia. It is one of the largest sources of food in urban and in most rural Ethiopia. Consequently, the largest share of resources is allotted to the production of this crop. A growth change in this food crop can greatly affect the food sector in the country. The main purpose of this paper is, therefore, to demonstrate the trend of Total Factor Productivity of Tef after economic reform and to evaluate the potential of this important crop in reducing food deficit in the sector. A Stochastic Frontier Model was applied to explicitly identify the magnitude of changes in the efficiency and technological progress, which together form Total Factor Productivity (TFP). A cross sectional-time series data from rural farm households was used for the period of 1994 to 2001.

The result of the study shows that the changes in policy and institutions significantly improved the production efficiency of the crop by about 20 % in the study period. On the other hand, technological progress was severely deteriorated (36 %) in the same period. Disappointingly, the decline in the technological progress surpassed the improvement in production efficiency and ultimately resulted in TFP to fall by 25 %. In addition, it has been found that sample farmers were producing at increasingly inefficient scale of operation implying over utilisation of resource in Tef production indicating failure of markets to guide efficient resources allocation.

These findings have shown that economic reform alone is not a panacea for increasing food production and growth in general. Technological advancement is the other important component of growth missing in the production of Tef in this country. Thus, improving techniques of production of Tef by generating better performing varieties and agronomic practices would be imperative. Furthermore, encouraging more competition in product and factor markets for better resource use would be advisable.

**Keywords:** Efficiency change, Ethiopia, food production, policy reform, technological deterioration, Tef

## Do Green Manures Have a Future in Rice-based Systems of Southeast Asia?

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Intensification of the land use in lowland-rice-based cropping systems of Southeast Asia has been associated with the widely observed decline in yields and factor productivity. When faced with declining crop yields, farmers have traditionally opted for the insertion of green manures into the farming system. In the 1970s soil-improving plant species has been cultivated on an estimated 30 million hectares. Despite the growing concern about the sustainability of the emerging intensive cultivation systems, the use of green manures is limited today to less than 1 million hectares. Farmers generally attempt to compensate for declining yields with a higher and increasingly inefficient use of external inputs. Have Asian farmers forgotten an important part of their (agri)cultural heritage or are green manures a thing of the past? Based on a critical analysis of more than 400 published studies, the potential and constraints of green manures use are analysed, possible cropping niches are defined, and future perspectives are proposed.

Green manures can accumulate on average  $80 \text{ kg N ha}^{-1}$ , which is derived to a major share from biological  $\text{N}_2$  fixation and/or from the sequestration of native soil or added fertiliser N. Yield increases and N use efficiencies achieved with green manures are similar or more than those with mineral fertilisers in rainfed lowlands with sandy soils. However, a low availability of P strongly reduces the performance of nitrogen-fixing species in these environments. Furthermore, only in the rainfed lowlands with a single transplanted crop do land and labour availability allow farmers to cultivate crops for the sole purpose of soil improvement. Once green manures systems provide multiple use solutions, they may become acceptable, since farmers are looking for direct returns to their investments. It becomes apparent that the niches for green manure are limited to marginal environments in infrastructurally little developed areas. Unless there is a significant increase in mineral fertiliser prices and/or progress in the identification of green manures with direct economic functions, the use of soil-improving plant species will continue to play only a limited role in the lowland agriculture of Southeast Asia.

**Keywords:** Azolla, N use efficiency, *Oryza sativa*, Sesbania

## The Potential of the System of Rice Intensification (SRI) for Poverty Reduction in Cambodia

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The system of rice intensification (SRI) was developed in the highlands of Madagascar and comprises a set of individual practices. In 2000, SRI was introduced to Cambodia and, since then, has attracted an increased number of farmers and projects. In order to facilitate the systematic analysis of experiences with SRI in Cambodia the Food Security and Nutrition Policy Support Project (FSNPSP)/GTZ together with the Community Based Rural Development Project (CBRDP)/GTZ and CEDAC initiated a survey on the potential of SRI for food security in Cambodia in early 2004.

The consultancy mission comprised a survey conducted in five provinces based on individual interviews covering 400 SRI and 100 non-SRI practising farmers. In addition, farmer group discussions and stakeholder discussions supplemented the survey results.

Farmers applying SRI followed to a large degree the recommended practices. Timely weeding and water management with alternate flooding/drying were among the most difficult practices for farmers. However, SRI requires intensive training with a high demand for human and financial resources.

With significant lower fertiliser inputs SRI increased rice yields from 1629 to 2289 kg ha<sup>-1</sup>, an increase of 41 %. The increased yield levels could be maintained for at least three years, indicating sustainability at least for the medium term. However, fields chosen by farmers to apply SRI were close to the homestead and of higher soil quality. The potential of SRI for poor environments to increase yields was rather low.

A further advantage of SRI was its ability to break the labour peak during uprooting/ transplanting while the overall labour balance was neutral. SRI increased both the land and labour productivity compared to conventional practices.

Farmers using SRI for the first time applied it on 21 % of their rice area while more experienced farmers doubled the proportion. Hence, at household level, the marginal profit due to SRI was sufficient to supply the household's needs for rice for 2.2 and 4.6 months, respectively. It was concluded that SRI is a promising management practice to be included into the national strategy for poverty reduction.

**Keywords:** Adaptability analysis, Cambodia, food security, labour, SRI, yields

## **Innovations for Plant Production in the Risky Environment of Semi-arid Niger — A Multi-level Modelling Assessment**

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The paper deals with sustainable technological innovation for smallholder agriculture in semi-arid Niger. For these farmers, a set of low-input technologies, amongst them pocket placed phosphorous fertiliser techniques, mulching and no-input techniques like selected weeding, have been developed in the nineties to increase the productivity of their millet farming systems. Technology assessment cannot be restricted to plot or farm alone but has to take into account also markets and marketing patterns. Consequently, a sequence of three models was applied: On plot level, technical production functions of intercropping systems were estimated. The parameters estimated depicted the influence of inputs and agro-ecological conditions on crop yields. By feeding different rainfall scenarios into the model, crop yield variability was depicted. The yields resulting from the model scenarios were fed in a Markowitz-Portfolio-farm model type by means of nonlinear programming to test the innovations at farm level. The model assumes risk and risk aversion as decisive factors for cropping decisions, with risk defined as the variability of yields and resulting financial returns. The base run was done at stable prices. The scenarios were run at declining prices which were obtained from the third modelling stage, an interregional trade model. The trade model was shocked by the excess obtained from the yield gains of the innovations. A certain amount of the production had to be marketed, even at declining prices, assuming that farmers had to cover their monetary costs of production from markets, especially for mineral fertiliser innovations. Results show that due to risk aversion and high price volatility of output markets, farmers adopt the more cost intensive technologies, like mineral fertiliser applications, to a lesser degree than expected. Instead, they switch to other low-input techniques, like field management such as selected weeding, which requires far less financial inputs. It can thus be concluded that, in a risky environment like the semi-arid Niger, low to zero cost management techniques are more likely to be adopted than more productive but more risky fertiliser technologies.

**Keywords:** Agricultural development, innovations, Niger, plant production, risk management, small scale farming

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## Adoption of Organic Cotton in Benin — Does Gender Play a Role?

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Benin, the number 12 in world cotton exports (2002), relies heavily on this crop for its export revenue (64 %). More than 90 % of pesticides imported in the country are used on cotton crop. The adverse environmental, health and economic problems conduced to the introduction of organic cotton as alternative to make more sustainable the cotton production in the country.

Since 1996, organic cotton production is gaining importance despite its labour intensity and though yields are around 0.5 ton compared to 1 ton in the conventional sector. In addition, it became attractive for women. They are directly engaged in organic cotton production by getting their own field, a situation which is not common in conventional cotton.

This study aims at clarifying various factors that determine the adoption of organic cotton and the role of the gender in this process. Data for this study were collected from 200 households (50 % conventional and 50 % organic) in central Benin where there are more than 60 % of area grown with organic cotton in the country. Gender is defined, not in terms of women or men, rather as the weight of women contribution to household labour and income.

The results show that the main reasons of adoption are based on desire for stable income, lack of transparency in the conventional sector and health. Only 1 % of respondents adopt because of environmental reasons. On the side of non-adopter, the low yield and the lack of information are the main reasons. Contrary to what one would expect, only 8.8 % of respondents do not adopt because of labour intensity.

Econometric models reveal that the adoption of organic cotton by the households is determined by a range of socio-economic factors among which gender, as defined, is very significant

**Keywords:** Benin, Gender, adoption, organic cotton

## Evaluation of Improved Pearl Millet Varieties with Farmers in West Africa

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Participatory varietal selection trials were conducted to evaluate farmers' preferences and the performance of improved pearl millet (*Pennisetum glaucum* L. R. Br.) varieties in Burkina Faso, Mali and Niger during the 2002 and 2003 seasons. Farmers from the pearl millet growing ecological zones were selected with the assistance of local partners, based on their willingness to test the improved pearl millet varieties, availability of land and accessibility to the fields. The trials were conducted with 195 farmers from 23 villages, who tested 11 improved pearl millet varieties, with their local variety acting as controls. Within a country, three villages were selected in each agro ecozone (region), while ten farmers were selected in each village except Dogon-Doutchi in Niger, which had five. Each farmer tested one to two pearl millet varieties. The characteristics in the improved pearl millet varieties preferred by farmers were maturity cycles of 80 – 90 days, high grain yield, long (30 – 100 cm) and compact panicles, high tillering with panicles, adaptation and acceptable taste. Out of eleven tested improved pearl millet varieties, farmers preferred the varieties SOSAT C88, ICMV IS 89305, ICMV IS 92222, ICMV IS 92326, ICMV IS 94206 and ICMV IS 99001. Farmers preferred their local varieties Balbou, Kapelga, Toronio, Niou and Haini Kirey mostly for the characteristic of adaptability and taste. The improved varieties gave yields ranging from 7 to 147 gm<sup>-2</sup> compared to the locals that gave 12 to 134 gm<sup>-2</sup>. The variety trials emphasise the need to integrate farmers and other users and use of wide crosses that incorporate landraces in the improvement of pearl millet varieties. To sustain the adoption of improved varieties, village seed production should then be promoted.

**Keywords:** Farmers preferences, participatory variety selection, pearl millet, West Africa

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## **Adaptation of Cultivation Measures in Enset (*Ensete ventricosum*) to Different Climatic and Cultural Conditions**

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Enset (*Ensete ventricosum*, Musaceae) is grown in southern and south-western Ethiopia for its starch containing leaf sheaths and corm. It serves as staple or co-staple crop for about 15 million people. Moreover, it is used for manifold properties in household, agriculture and traditional medicinal treatments. Cultivation occurs between 1500 and 3300 meters altitude among several ethnic groups. It is grown in plantations consisting of several age groups, and of a wide range of landraces with differing site requirements and properties for use. To keep the identity of the landraces they are propagated vegetatively by sprouts. However, propagation by seed is practised in some regions.

Two regions with enset as staple crop (Gurage and Sidamo) and co-staple crop (Welaita and Gardula), respectively, highlight the varying possibilities for enset cultivation, and show constraints and prospects of each cultivation measure. Most important are differences in propagation period and techniques, plantation management, and the cropping system that integrates enset cultivation. Propagation lasts from December to May. Propagation techniques vary in the treatment of the corm preparation to induce sprout development. Plantation management includes thinning or transplanting of enset to guarantee sufficient space for the growing plants, period from separating sprouts until harvest, and number and properties of landraces. Cultivation systems are hoe and mixed hoe-plough systems. They include animal husbandry, arable crops, vegetables, fruit crops and cash crops. Intensity of each crop depends on climate and significance for each ethnic group, and so do enset cultivation measures. The cultural influence on cultivation measures is much stronger than the influence of climate. Therefore, changes within one region vary less under different climates than within several regions with comparable climatic conditions.

**Keywords:** Climate, cultivation measures, cultivation systems, *Ensete ventricosum*, plantation management, propagation, regional cultures, Ethiopia

## **Bokashi Composting and the Effects of EM-Bokashi on Growth of Young and Adult Banana (*Musa* sp.)**

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Effective microorganisms (EM) are often used in low-external input agricultural systems of the humid tropics to accelerate composting and enhance plant growth. However, little process-oriented research has been done to substantiate these effects and unravel possible mechanisms. This study aimed at comparing the effects of EM addition on the decomposition of banana (*Musa* sp.) residues and on banana root and shoot growth to those of an untreated control and a series of other composting additives.

In comparison to non-EM controls (EM-‘Bokashi’ produced from composted banana residues with: w = water, m = molasses, EM<sub>st</sub> = sterilized EM), EM did not increase the mineralisation of banana compost. Nitrogen concentration was highest in EM<sub>st</sub> (17.1 g kg<sup>-1</sup>) and lowest in EM (15.3 g kg<sup>-1</sup>). The highest C concentration was found in EM (492 g kg<sup>-1</sup> after 30 days of composting) and the lowest in EM<sub>st</sub> (436 g kg<sup>-1</sup>). The resulting C/N ratio was 33.5 for EM and 25.6 for EM<sub>st</sub>. Concentrations of K, P, Ca, Mg and a weight loss of approximately 77.9 % were similar for all treatments. The ergosterol concentration was significantly higher in EM-Bokashi (77 mg g<sup>-1</sup>), whereas it was lowest in EM<sub>st</sub> (29 mg g<sup>-1</sup>). Application of all compost variants significantly increased shoot growth of young banana plants under greenhouse conditions compared to controls grown in pure soil (final height in cm: c = 62.3; w = 69.5; EM = 70.8; m = 72.0; EM<sub>st</sub> = 72.7). EM-Bokashi and Bokashi produced with molasses significantly decreased the number of root nematodes under greenhouse conditions as compared to the control (nematodes per 100 g: c = 254; w = 143; EM<sub>st</sub> = 143; m = 67, EM = 38). Although root growth of the plants in the greenhouse was not improved by the Bokashi variants, EM-Bokashi increased secondary root growth of adult banana plants in the field (EM = 186.7 g) compared to non-composted fresh banana leaves (fb = 134.6 g) and a control without mulch application (c = 147 g). Molasses produced the lowest root mass (104.2 g).



## **Propagation of Enset (*Ensete ventricosum*) among Different Climatic and Cultural Conditions**

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Enset (*Ensete ventricosum*, family Musaceae) is grown in southern and south-western Ethiopia. It provides high starch yields from its leaf sheaths and corm. Therefore, it serves as staple or co-staple crop for about 15 million people. Moreover, it is used for manifold properties in household, agriculture and traditional medicinal treatments. Enset is cultivated between 1500 and 3300 meters altitude among several ethnic groups. It is grown in plantations consisting of several age groups and landraces. Vegetative propagation allows cultivation at high altitudes, when seeds are not developed. It also provides a high number of plants, and homogenous plant material.

Propagation techniques are described for ten regions. At least ten farms were visited in each region and farmers were interviewed about their propagation practices. Results are compared with results of field experiments in 1998–99 on propagation at two altitudes (1850 and 2350 m) and three propagation dates (February, April and August).

Vegetative propagation of enset enforces cutting down of an enset plant close to the ground. Afterwards, the apical meristem is removed and leaf sheaths are either removed or pulled apart. This breaks the apical dominance and enables development of callus, from which numerous adventitious sprouts appear after about three months.

Treatments during the propagation process vary regarding climate and ethnic group. This includes (1) uprooting of mother plants, (2) drying the corm, (3) splitting the corm, (4) wounding the apical meristem (5) filling the corm with soil, manure or gravel, and (6) planting, protection and manuring of the propagated corm. All measurements must not be performed. In one region the same mother plant was used two times for propagation. At altitudes above 2800 meters special treatment was mentioned before planting the corm into the final plot. Field experiments did confirm the necessity of different propagation periods regarding different climatic conditions.

**Keywords:** Climate, *Ensete ventricosum*, propagation, regional cultures, Ethiopia

## Technological Innovation in Processing of Coconut Water in Brazil

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For small scale farmers in north-eastern Brazil the cultivation of the coconut tree (*Cocos nucifera* L.) is of major importance to generate family income. In the last years the water of the unripe green coconut has got more and more importance on the Brazilian market because of the change of the consumers behaviour shifting from sweet artificial to more natural isotonic drinks.

Traditionally most coconut water is consumed direct from the fruit. While the large consumer centres are located in the south of the country the fruits have to be transported over up to 4000 kilometres resulting the transportation costs to be the major part of the sales price. Eighty percent of the transported good is coconut fibres and only twenty percent is the wanted water. In addition the coconut fibres are an increasing problem in the waste deposit of the cities. In view of this problem the Institute of Agricultural Engineering in the Tropics and Subtropics in cooperation with Weiß Getränke GmbH developed a new concept for the extraction and conservation of coconut water.

In on-farm trials the nut opening method was improved by replacing the traditional manual opening using a machete by introducing a modified wood splinter: The cotter was replaced by a knife made from stainless steel to cut the coconut. To collect the extracted coconut water a basin was assembled to the platform of the splinter.

To make a packaging on farm level possible a micro factory was designed using a filter unit followed by a pasteurisation plant and a bagging assembly, where for the first time in coconut water processing the bag in box system was introduced which is well known in Europe in trading of wine and fruit juices. Finally the water was filled in bags and enabled to cool down on ambient temperature before being sold to wholesalers.

This technology innovation enables farmers and communities in rural areas to process their coconuts and produce a marketable product. This increases family income and avoids transportation efforts and waste deposit in the cities whereas the fibres can remain on the farm.

**Keywords:** Bag in box, green coconut, processing

## **Biomass Production and Gas Exchange of Tamarind (*Tamarindus indica* L.) Seedlings Subjected to Repeated Cycles of Water Stress**

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Tamarind (*Tamarindus indica* L., Leguminosae) is a tropical multipurpose tree with many uses, ranging from food and beverages to medicinal and industrial purposes (Morton, 1982). The ripe tamarind fruits are consumed fresh, in desserts, or processed into refreshing soft drinks enjoyed during hot summer months in the Sudan. The plant is native to tropical Africa and grows wild throughout the Sudan., but is cultivated on a commercial scale mainly in India, Thailand, the Philippines and Mexico. Tamarind plantations in the Sudan are practically non-existent and wild stands are continuously being overexploited to meet local consumption and export. Unsustainable harvesting methods of wood and fruit, livestock grazing, land clearing and bush fires pose a great threat to natural stands. Risks are further amplified by recurrent episodes of drought, which plagued the country since 1983. Effects of drought are particularly severe on seedlings or new transplants because their roots occupy the uppermost layers of soil where the most rapid drying occurs

Plants have evolved many physiological, morphological and anatomical characteristics to become better adapted to water-scarce environments. A better understanding of the way that drought stress affects plants would help in the development of improved cultivars and better production systems to reduce the effects of drought. This paper described changes biomass production and leaf gas exchange of *Tamarindus indica* seedlings subjected to repeated cycles of drought in comparison to well-watered seedlings. Results suggest that the growth decrease in WS-plants was related mainly to growth inhibition of aboveground parts and, to lesser degree, to a decrease in root growth. In WS-seedlings, root/shoot ratio was 0.25 compared to 0.21 for the control plants. This may indicate an adjustment in biomass allocations pattern to favour root tissues at the expense of shoot tissues. Greater root biomass will tend to increase the capabilities of water uptake while at the same time lower shoot biomass would be expected to reduce the amount of water loss due to an expected smaller leaf area. It may also reflect greater ability of roots to maintain turgor through osmotic adjustment.

We are grateful to the 'Alexander von Humboldt Foundation' for awarding a Feodor Lynen Research Fellowship to Dr. Jens Gebauer.

**Keywords:** Biomass production, leaf gas exchange, tamarind, water stress

## Physiological and Morphological Responses of Sorghum Bicolor to Static and Dynamic Drought Conditions

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Drought is a major abiotic stress that severely affects agricultural systems and food production. It is generally accepted to be the widest spread abiotic stress experienced by crop plants and the major limiting factor to crop production in most areas of the world, especially in the tropics. Intermittent drought at critical stages of cereal crops reduces yield.

Sorghum, grown extensively in the dry parts of the tropics, is reputedly one of the most drought tolerant crops. Yields are still limited by drought because most of the mechanisms of drought tolerance, their interactive effects, and associated morphological and physiological modifications and symptoms have not been fully identified and/or understood by plant breeders and plant physiologists.

An experiment has been set up in a green house to investigate the morphological and physiological responses of a sorghum genotype grown in two different soil types and subjected to permanently sub-optimal water availability in contrast to a drying cycle with subsequent re-watering.

A sorghum variety (ICSV 111 IN), was planted in pots constructed from PVC pipes with internal diameter of 0.15 m and 0.5 m height. Each pot was subdivided into 4 sections of 0.125 m height held together by cellotape to facilitate the easy assessment of moisture and root distribution within the pots. Two soils (sandy loam and loamy sand), differing in matric potentials, and three different water treatments (field capacity (control), constant drought, and dynamic drought) were used for the study.

Biomass partitioning, root biomass development in four soil depths, root water potential, chemical composition of the xylem sap, transpiration and photosynthesis will be studied in relation to available soil water content, matric potential of the soil and soil type. The results are expected to elucidate whether the plant responds to the total amount of water available or to the pressure gradient between xylem and soil. Implications for modelling and genotype development will be discussed.

**Keywords:** Biomass partitioning, drought, root-shoot-communication, soil properties, sorghum

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## Agroforestry Use of *Inga edulis* in the Peruvian Amazon

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Amazon rain forest has witnessed high rate of deforestation during the last 3 decades. The major cause of this deforestation is traditional small-scale shifting cultivation with the farmers using mainly slash-and-burn methods. Approximately 0.5 % (350 000 ha) of the Peruvian Amazon is converted to cropland or pastures each year, with greatest rates of deforestation occurring around population centres, such as Pucallpa, the capital of Ucayali region. Farm productivity in the Peruvian Amazon basin may be increased through the promotion of agroforestry in conjunction with the domestication of native tree species. This improved farm productivity through agroforestry is expected to reduce deforestation rates by decreasing demand on primary forests.

The objective of the first research was to evaluate ecological sustainability of traditional land use systems in Peruvian Amazon basin around the city of Pucallpa in comparison with improved agroforestry systems, then to design improved agroforestry system and to establish demonstration plots on the farmer's field using Participatory Technology Development methodology. The computer simulation of this land use systems was done, using computer model SCUAF (Soil Changes Under AgroForestry). A farming system of planted leguminous tree fallow was modelled. The system involves establishing an *Inga edulis* plantation in the fallow period, which is an adaptation of the improved fallow agroforestry systems. The *Inga* fallow system was compared with a traditional shifting cultivation fallow system and the results indicate that the system with *I. edulis* is more sustainable than traditional shifting cultivation system.

Following these results 13 demonstration plots (50 × 50 m) were established on farmers field in two communities around the city of Pucallpa. For the control of noxious weeds (e.g. *Imperata brasiliensis*) the establishment of *I. edulis* plantation was combined with 3 cover crop legumes (*Mucuna pruriens*, *Pueraria phaseloides*, *Centrosema macrocarpum*). The plots are managed by farmers and the growth of *I. edulis*, growth of weeds and soil changes will regularly be monitored. The economical and ecological sustainability will be evaluated during the time.

**Keywords:** Agroforestry, *Inga edulis*, Peruvian Amazon, SCUAF, shifting cultivation

## Dry Synthetic Seed Production and Desiccation Tolerance Induction in Somatic Embryo of Sweet Pepper

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The conventional hybrid seed production of sweet pepper (*Capsicum annuum* L.) is a long process with various problems of interspecific incompatibility and higher number of F1 hybrid sterile. Synthetic seed technology may be of value in breeding programs and allow the propagation of many elite genotype-derived plants in a short time. The ability of somatic embryos to withstand drying to low moisture contents is important for storage, and plays a big role in the developmental transition between maturation and germination. Nodular, friable, and yellowish sweet pepper embryogenic callus developed from mature zygotic embryos cultured on MS (Murashige and Skoog) agar basal medium supplemented with 3 mg/l 2,4-D and 3 percent sucrose under light condition. Somatic embryos were induced and achieved by using embryogenic cell suspension culture in liquid MS basal medium, which supplemented with 1 mg/l 2,4-D and 3 percent sucrose. Somatic embryos at the torpedo stage were subjected to various different treatments in order to achieved increase somatic embryos desiccation tolerance. The treatments were exogenous applications of abscisic acid (ABA) in various concentrations (0.1–2.0 mg/l). It was found that somatic embryos which treated with 0.5 mg/l concentration of ABA for 20 days before encapsulated with 3 % sodium alginate, and dehydrated in the laminar flow hood until 80 percent water loss still remained germinated to 58 percent. Furthermore improvements of dry somatic embryos can be accomplished by adding 60 g/l sucrose in the maturation medium, which resulted 40 percent of plantlets conversion after 4 weeks of storage in ambient temperature. The poor success number of viable synthetic seedling from this experiment showed that there is still some more researches needed in enhancing seedling vigorous in order to achieved better of survival germinated seedling.

**Keywords:** *Capsicum annuum*, desiccation tolerance, sweet pepper, synthetic seeds

## Consumer Acceptance and Sensory Attributes of Different Salak Cultivars (*Salacca zalacca* GAERTN. VOSS)

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The worldwide market and demand for new exotic subtropical and tropical fruits, revealing a high nutritional and sensory value, has significantly increased in the past few years. Among these crops, the palm tree salak fruit, originating from South-East Asia, has a high potential as an export crop for the fresh market. Among the 30 cultivars in Indonesia, pondoh is the most promising one since it provides superior fruit quality especially in respect to its taste being sweeter with no bitter or sour taste components in comparison to other cultivars, even at early ripening stages. To enter the international market, the knowledge about consumer acceptance and sensory attributes is very important.

The purpose of this study was to analyse aroma and volatile compounds and to evaluate the sensory attributes of different salak cultivars. A descriptive panel evaluated the sensory profile of four salak cultivars, i.e. cv. pondoh manggala, cv. pondoh hitam, cv. pondoh super and cv. gading. For the identification of aroma compounds, GC/MS and gas chromatography-olfactometry (GCO) using the nasal impact frequency (NIF) method have been performed.

The panels evaluated the following attributes with a high ranking: appearance, taste intensity, colour, firmness, size and after taste. In respect to 'sweetness' the following ranking was done: cv. pondoh manggala, cv. pondoh hitam, cv. pondoh super and cv. gading. The 'acidity' of salak fruits was evaluated as medium. By GC/MS, a number of 50 compounds were identified (esters, acids, alcohols and furanons). In GCO analysis, 17 important volatile compounds were detected and 14 were identified. Important aroma descriptors of the volatile compounds were the following: fruity, green, sweet, pleasant, flowery, pineapple, potato, cheesy, overripe, chemical, metallic, burned, sweaty and unpleasant. In conclusions, the consumer accepts salak fruit in respect to its appearance and taste. However, in respect to aroma, more studies on consumer acceptance of salak fruits are needed for further worldwide marketing purposes.

**Keywords:** Consumer acceptance, salak fruit, sensory attributes

## Phenological Responses of Rice Cultivars under Varying Thermal Environments in High Altitude Cropping Systems

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Nepal's most important crop production system is the rice - wheat rotation cropping. Rice is the most important food crop of Nepal and is cultivated under a wide range of ecological conditions. This crop is grown from elevations of 60 m asl up to 3050 m altitude, which is the highest altitude in the world for rice cultivation. The average yield of rice in Nepal is 2.7 t<sub>ha</sub> in Nepal. The rice-wheat crop rotation is characterised also by a more or less prominent transition period between the harvest of the wheat and the planting of the rice, that can be used to grow spring crops like mung bean, sunflower etc. The length of the transition period differs with the climatic environment and is directly related to the elevation above sea level of the production system. Proper management of this transition period leads to nutrient conservation and more efficient nutrient use of the following rice crop and in the long run increases the sustainability of the system. Such transition season crops and/or the replacement of the dry season wheat by a crop of potatoes, can result in a substantial deviation from the recommended transplanting date for rice. In those cases, both early and late planted rice can experience periods of thermal stress that may extend the duration to flowering and /or result in cold-induced spikelet sterility. In cases where, in order to fit a transition crop, deviation from the normal transplanting time for rice (June and July) crop duration becomes the major agronomic parameter determining the agronomic fit of a rice genotype. Crop duration determines the ability of the crop to escape from climatic stresses, for example thermal stresses occurring during the cold or hot season in semi-arid and mountain environments. The identification of rice genotypes adapted to different planting times is crucial to enhance the productivity of rice based systems within the merging modified cropping calendars. This study investigates phenological and yield component responses of some 30 rice genotypes to staggered fortnightly seeding dates to ultimately develop a risk assessment tools for cropping calendar adaptation.

**Keywords:** Cropping calendar development, Nepal, risk assessment, sterility, temperature responses

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## Effects of Temperature and Grafting on the Growth and Development of Tomato Plants under Controlled Conditions

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Tomato (*Lycopersicon esculentum* MILL.) is a warm season vegetable crop with an optimum temperature for production of 28/22 °C (day/night). Heat stress is a major environmental stress that limits tomato production during summer under arid conditions. A variety of control measures and techniques including cultural practices in the field have been tested at the University of Khartoum in Sudan for tomato production under high temperature. Additionally grafting techniques have been used with heat sensitive and heat tolerant cultivars and with heat sensitive tomato cultivars as scion and eggplant cultivars as rootstock.

The objective of this study is to examine if there is any positive effect of grafting on the vegetative and reproductive development in tomato plants. Further, grafting effects were investigated on tomato plants under heat stress conditions.

The heat tolerant tomato cultivar ‘Summer set’ and the eggplant cultivar ‘Black beauty’ as rootstock as well as the less heat tolerant tomato cultivar ‘UC 82-B’ as scion were selected. Plants were grown under two temperature regimes 30/22 °C and 38/27 °C (day/night) in plant growth chambers at the Department of Vegetable Crops, Institute for Horticultural Sciences, Faculty of Agriculture and Horticulture, Humboldt University of Berlin. The experiments were set up in a complete randomised design with five plants for each treatment. The following characteristics were recorded: leaf area, fresh and dry weight of leaves and stem, fresh and dry weight of roots, number of clusters, number of flowers, and the number of pollen grains per microscopic field. In addition chlorophyll fluorescence and electric conductivity were measured, suggested as a screening technique for heat tolerance.

Significant differences were encountered between treatment UC 82-B/Black beauty and UC 82-B under 38/27 °C for chlorophyll fluorescence, electric conductivity and other vegetative and reproductive parameters. On the whole, grafting may have slightly positive effects on tomato production under high temperature conditions.

**Keywords:** Arid conditions, grafting, heat stress, tomato

## Effect of Different Nitrogen Sources to Wheat on Two Soils in Sudan

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Wheat (*Triticum aestivum* L.) cultivation in Sudan expanded in the last decades to latitudes lower than 15 °N as a winter crop, occupying the largest area in Sudanese irrigated schemes, and it is the second most important cereal crop after sorghum in the country. The demand for wheat increased due to urbanisation, but there is a large deficit of production compared to consumption. Average wheat yields in Sudan are very low, due to climatical and to production factors. Nowadays, many different fertiliser forms are introduced in Sudan to raise wheat yields.

The objective of our study was to test the effect of different nitrogen fertilisers on wheat yield and quality. The fertilisers used were urea, Nitrophoska, ammonium sulphate and ammonium sulphate nitrate. N, P, K and S were applied in same amounts on all plots, only the N fertiliser form was different. The experiment was conducted on two typical wheat soils of Sudan, a Vertisol, non saline and non sodic, in the Gezira scheme in the Center of Sudan, latitude 14.3 °N, and an Aridisol, non saline, but slightly sodic, latitude 15.5 °N, in the dryer region near Karthoum. The wheat variety Debeira was sown in two seasons, on November 15 of 2001 and of 2002. Two levels of fertiliser were applied: 1 N and 2 N (1N = 43 kg N ha<sup>-1</sup>).

Our results showed a significant increase of grain yield and of grain protein content with increasing nitrogen level from all fertiliser sources on both soils and in both seasons. Nitrophoska outyielded the other nitrogen sources, followed by urea, ammonium sulphate nitrate and ammonium sulphate. Maybe there were less NH<sub>3</sub>-losses by volatilisation from Nitrophoska than from the other fertilisers. These NH<sub>3</sub>-losses are severe in Central and Northern Sudan, as most of these soils are high-pH soils.

The Gezira Vertisol, situated more in the South, gave a higher wheat grain yield, but a lower grain protein content than the Aridisol in the dryer climate near Khartoum. So, different climates and different soils are responsible for different yield and protein contents of wheat in the study areas of Sudan.

**Keywords:** Aridisol, nitrogen fertilisers, vertisol, wheat

## Mungbean Seed Longevity and Quality Influenced by Initial Seed Moisture Content and Storage Temperature

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Mungbean seeds (*Vigna radiata* (L.) WILCZEK) ev. cultivar Chainat 72 (CN 72) which were stored at various conditions. The treatment were: four initial seed moisture content of 7, 9, 11 and 13 percent and four storage temperatures of 15, 20, 25 degree Celsius and including room temperature (27–32 degree Celsius). Storage period was 18 weeks and seed quality assessments were investigated in every 3 weeks. This following parameters were recorded: standard germination test, vigour test by accelerated aging technique, seedling growth rate and electrical conductivity from seed exudates, tetrazolium test for viability, seed health testing, insect infestation, seed protein, seed carbohydrate analysis. The results, showed that in all conditions the percentages of germination and viability test remained above 94 percent and 96 percent respectively. Seed vigour by accelerated aging technique and seedling growth rate were decrease after longer term time of storage and vigour test by electrical conductivity showed the the increasing of seed exudated. Percentage of fungi infection increased after longer times of storage from 40 to 83 percent and found of most fungi infections were *Aspergillus flavus* and *Aspergillus niger*. Protein (20.9 to 20.6 percent) and carbohydrate (62.5 to 62.1 percent) contents in all conditions tended to decrease but were not significant difference, insect has not been found. The results indicated that, initial seed moisture contents had influenced in seed of germination, vigour, viability and quality after storage more than storage temperatures and showed the relationship between seed moisture content and storage temperatures and their storage potential. This relationship can be use to apply for storage mungbean seed and used to predict viability and quality of mungbean seed during storage. The optimum of mungbean seed moisture content for safe storage is 7 percent and the best storage temperature is 15 degree Celsius.

**Keywords:** Seed moisture content, seed quality, storage, temperature

## Prediction of Mungbean Seed Longevity and Quality Using the Relationship of Seed Moisture Content and Storage Temperature

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The prediction equation of mungbean seeds viability and quality in relation to seed moisture content and storage temperature were established. Mungbean seeds (*Vigna radiata* (L.) WILCZEK) ev. cultivar Chainat 72 (CN 72) with four initial seed moisture content of 7, 9, 11 and 13 percent and four storage temperature of 15, 20, 25 degree Celsius including room temperature (27–32 degree Celsius) were studied. Seed were stored for 18 weeks and the assessments were done every 3 weeks. Multiple regression were analysed: standard germination test, vigour test by accelerated aging technique, seedling growth rate and electrical conductivity from seed exudate, tetrazolium technique for viability, fungi infection, insect infection, protein and carbohydrate content were investigated. The regression equation for predicting the viability were by following: dependent variable (Y), independent variables were initial seed moisture content (X1), storage temperature (X2) and period of storage (X3). The best equation resulted by seedling growth rate which  $Y = 26.153 - 0.878 (X1) + 0.147 (X1 \times 3) + 0.039 (X12) - 0.007 (X12 \times 3) - 0.025 (X2) - 0.558 (X3) - 0.01 (X32)$  ( $R^2 = 0.9615$ ). The others equation are electrical conductivity  $Y = 80.757 - 1.771 (X1) + 0.069 (X1 \times 2) + 0.153 (X1 \times 3) - 0.343 (X2) - 2.654 (X3) + 0.172 (X32)$  ( $R^2 = 0.9595$ ) and accelerated aging  $Y = 118.414 - 2.180 (X1) + 0.047 (X1 \times 2) + 0.369 (X1 \times 3) - 0.019 (X12 \times 3) - 0.873 (X2) - 2.996 (X3) + 0.043 (X32)$  ( $R^2 = 0.9119$ ). This equation could be used to predict viability and storability of mungbean seeds under above mentioned condition, their predicted result were closely to the observed values of mungbean seed qualities.

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

## **Radio Frequency Heat Treatment to Controlled Seed-borne *Macrophomina phaseolina* in Sesame Seed (*Sesamum indicum* L.)**

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*Macrophomina phaseolina* is the main seed-borne fungus in many of seed crops especially in sesame. This study was to evaluate possibility using radio frequency heat treatment to control seed-borne fungus. Three variety of sesame from Thailand, Maharakam 60 (MK60, white seed), MG 18 (black seed) and Aubon 1 (AU1, red seed) with initial seed moisture content of 5 and 10 percent were treated with various of radio frequency heat treatment of 60, 70, 80, 85, 90 degree Celsius for 180 seconds. Seed-borne fungi were assayed by using 2 method. PAD method (Potato Dextrose Agar), at seed moisture content 5 percent the existing of *M phaseolina* was 16, 11, 18 percent in MK60, MG18, AU1 whereas at seed moisture content 10 percent was 17, 15, 21 in MK60, MG18, AU1. Besides that, other 5 fungi viz. *Rhizopus* sp., *Aspergillus niger*, *A flavus*, *Curvularia* sp., *Penicillium* were found. Blotter method, at seed moisture content 5 percent the existing of *M phaseolina* was 15, 10, 13 percent in MK60, MG18, AU1 whereas at seed moisture content 10 percent was 16, 14, 15 in MK60, MG18, AU1., other 9 fungi viz. *Rhizopus* sp., *Aspergillus niger*, *A. flavus*, *Fusarium*, *Curvularia* sp., *Penicillium*, *Cladosporium*, *Alternaria* and *A. terrieus* were also found. However, among all fungi, *M phaseoliana* was the main principle decreasing germination percentage. Radio frequency had significantly showed the efficiency in controlling *M phaseolina*. The best level was at 70 degree celcius with seed moisture content of 10 percent, all fungi invasion was decreased to 51 percent whereas the percentage of seed germination was 73 percent. Sesame variety AU1 response to the treatments better than the others.

**Keywords:** *Macrophomina phaseoliana*, radio frequency, seed-borne fungus, sesame seed

## **An Economic Analysis of Split Application of Organomineral Fertiliser on Okra in Humid Forest Zone of Nigeria**

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Field experiments were carried out during cropping seasons on a sand loam soil, with okra (*Abelmoschus esculentus* Moench) at the Institute of Agricultural Research and Training, Ibadan Nigeria to evaluate the economic viability of split application of organomineral fertiliser on okra. The study involved the use of organic based fertiliser split applied at different rates. The treatment consisted of **(i)** 4 tonnes/ha compost applied once **(ii)** 2 split application of 4 tonnes/ha compost **(iii)** 3 split application of 4 tonnes/ha compost **(iv)** Single application of 2 tonnes/ha compost with 30 kg N/ha **(v)** 2 split application of 2 tonnes/ha compost + 30 kg N/ha **(vi)** 3 split application of 2 tonnes/ha +30 kg N/ha **(vii)** Recommended dose of inorganic fertiliser and **(viii)** control (no fertiliser application).

The three agro-economic indicators: increased yield, increased net returns and benefit cost ratio were employed in determining the suitability of split application of organic and inorganic fertiliser. Results showed that the most profitable practice was the 2 split application of 2 tonnes/ha compost enriched with 30 kg N/ha. The treatment produced a favourable 1.9: 1 benefit: cost ratio, increased net returns of between 20.2 % and 74.3 % per hectare and gave maximum profit per naira above other treatments hence its recommendation as a modest cultural practice. Fortifications of compost with mineral fertiliser reduced the cost of production, increased the net return and produced higher benefit: cost ratio. Based on the above it is concluded that 2-split application of 2 tonnes/ha compost + 30 kg/ha is economically suitable for okra production in the humid forest zone of Nigeria.

**Keywords:** Economic analysis, fertiliser, okra, organic manure, split application of fertiliser

## **Effect of Different Sources and Rates of Nitrogen Fertiliser on Growth and Yield of Sweet Corn**

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Rapid nitrate leaching due to current nitrogen management practices under the humid tropical environmental condition of the south western Nigeria, may contaminate fresh and salt water resources. It is becoming a major public concern because underground water is the sole source of fresh water especially in the south western part of Nigeria. Field studies were carried during the cropping seasons at Ibadan south western Nigeria to examine the effect of different sources and rates of nitrogen fertiliser on growth and yield of sweet corn. The main objectives of the study were to examine the use of organomineral fertiliser as a possible management alternative for reducing nitrate leaching due to nitrogen fertiliser applications as a result of applied inorganic fertiliser while also providing sufficient nitrogen for crop growth.

The effect of organomineral fertiliser and availability of nitrogen at rates up to 120 kgN/ha was also evaluated in the trial. The result favoured production of sweet corn at 120 kgN/ha. Highest total dry matter was obtained at 120 kgN/ha. The fresh cob weight of 14 tonnes and 17 tonnes/ha was obtained from 80 kg and 120 kgN/ha respectively while the chemical fertiliser treated plants produce the optimum grain yield.

The result suggests that the application of organomineral fertiliser may be a useful management practice to reduce nitrate leaching losses, improve soil structure and also reduce production cost by reducing the use of expensive inorganic fertiliser with the additional advantage of cleaning environment through the use of organic waste.

**Keywords:** Nitrogen rate, organomineral, sweetcorn

## **Seed Qualities, Chemical Compositions and Dehydrogenase Enzyme Activity of Sesame Seed Affected by Radio Frequency Heat Treatment**

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Three varieties of sesame seed, Mahasarakam 60 (MK60, white seed), MG 18 (black seed) and Aubon 1 (AU1, red seed) from Thailand with initial seed moisture contents of 5 and 10 percent were treated with radio frequency of 60, 70, 80, 85, 90 degree Celsius for 180 second. The result showed that the initial seed moisture content at 5 percent had decreased to 4.9, 4.6, 4.5, 4.1 percent and at the initial seed moisture content 10 percent had decreased to 9.3, 9.1, 8.8, 8.6, 8.3 percent according to the increasing of the higher level of temperature from 60, 70, 80, 85, 90 degree Celsius. High Radio frequency temperature (85–90 degree Celsius) is the most important factor affecting seed qualities such as seed germination and seed vigour. Whereas the initial seed moisture contents showed no significantly effects. Increasing of radio frequency temperature treatment decreased the percent of germination and seed vigour and led to increase the percent of abnormal seedling. The optimum temperature in drying seed by this method was 70 degree Celsius, seed moisture content decreased to 4.6 percent (5 percent initial moisture) and 9.1 percent (10 percent initial moisture), percent of germination were 86 and 85 percent and seed vigour is 69 and 60 percent, respectively. The radio frequency temperature at 85°C is the critical point, it had significantly affecting on increasing number of abnormal seedling and the chorotic spots were observed on cotyledon. MG18 resulted the best positive response from the radio frequency drying treatment (70 degree Celsius) with 88 percent of germination and 75 percent of seed vigorous. Beside that, the treatments did not show any significant changes in seed chemical compositions such as free fatty acid, total carbohydrate and protein content, but at the level of 70 degree Celsius treatment, it had significantly enhanced on dehydrogenase enzyme activities. Anyhow, the application at the temperature above 85 degree Celsius had reverse effects.

**Keywords:** Carbohydrate, dehydrogenase, free fatty acid, germination, protein, radio frequency, seed quality, seed vigour, sesame seed



## The Role of Silicon in the Control of *Pythium aphanidermatum* in the Protected Cultivation of Tomato and Bitter Gourd in Thailand

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Soil-borne plant pathogens are a major threat for the production of vegetables under conditions of protected cultivation. It has been shown that vegetable production in Thailand is especially limited by *Pythium aphanidermatum*, a root pathogen with a mainly tropical distribution. *P. aphanidermatum* mainly infects the roots of young plants causing poor plant growth and low yields.

Beneficial effects of silicon (Si) nutrition on plant health have been shown for many crops. Interestingly, so far most studies regarding silicon nutrition and plant health were conducted with silicon accumulator plants that are characterised by a high Si uptake as well as a high translocation rate to the shoots. In contrast, Si excluder plants discriminate Si at the plasma membrane leading to an accumulation of silicon in the root apoplast the site of *Pythium* infection.

In the present study Si effects on *P. aphanidermatum* disease were compared for a Si excluder and an accumulator plant, namely tomato (*Lycopersicon lycopersicum*) and bitter gourd (*Mormodica charantia*), respectively, under controlled conditions. Plants were grown in peat substrate low in silicon that was supplemented or not with Aerosil as a source of plant available Si. A pathogenic isolate of *P. aphanidermatum* originating from vegetable production sides in Thailand was used for inoculation.

For both species root length and shoot weight of three weeks old plants were reduced as a result of *Pythium* infection. In tomato, growth parameter did not differ between silicon treatments. On the other hand growth parameters of bitter gourd were clearly positively affected by addition of silicon. The results indicate that the beneficial effect of Si on plant resistance against *Pythium* is linked to symplastic rather than apoplastic effects of Si.

**Keywords:** Beneficial effects, *Lycopersicon lycopersicum*, *Mormodica charantia*, Protected cultivation, *Pythium aphanidermatum*, Silicon

## Options for Biological Control of the Parasitic Weed *Orobanche* in North Africa

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Broomrapes (*Orobanche* spp.) are the most economically important group of root parasitic weeds causing high yield losses in many essential crops mostly in the Mediterranean area, the Middle East and Eastern Europe. In North Africa, *Orobanche* constitutes a major constraint to food legume crops production and complete crop failure can be expected in case of heavy infestations. Application of natural enemies of *Orobanche* could be an effective control method to be combined to other control measures in an integrated weed management program. Consequently, surveys for natural antagonists (insects, fungi and rhizobacteria) of the parasitic weed *Orobanche* were carried out during the growing season of 2000 and 2001 in the major legume-cropping areas in the North African country Tunisia. Insects herbivores of *Orobanche* were investigated at 21 locations in northern Tunisia. Stems and fruit capsules from 315 *Orobanche* plants, sampled in faba bean (*Vicia faba* L.) fields, were examined separately for the presence of insects. *Phytomyza orobanchia* (Diptera: Agromyzidae) and *Smicronyx cyaneus* (Coleoptera: Curculionidae) were found to attack *O. crenata* Forsk. and *O. foetida* Poiret in almost all surveyed areas. Both insects inflict significant damage to the parasitic weed under natural conditions. One hundred and five fungal isolates were obtained from infected *Orobanche* underground stages with *Fusarium* spp. being the most prevalent. *Fusarium oxysporum* and *F. culmorum* showed promising control of *Orobanche* in screening experiments. Bacteria were isolated from the Rhizosphere of faba bean as well as from diseased *Orobanche* underground stages or suppressive soil samples. Of 351 bacterial isolates obtained, 337 were screened for antagonistic activity against both *Orobanche* species. Both, *Orobanche* seed germination stimulating bacteria and *Orobanche* growth inhibiting bacteria have been selected and had a significant antagonistic activity against the parasitic weed. Most promising isolates were *Pseudomonas fluorescens*, *Ps. marginalis* and *Ralstonia pickettii*. The diversity of natural antagonists of *Orobanche* in Tunisia provides promising prospects for the biocontrol of the parasitic weed.

**Keywords:** Biocontrol, *Fusarium* spp., Herbivores, *orobanche* spp., *Pseudomonas* spp., Rhizobacteria, Survey, Tunisia

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## Seed Priming Enhances Germination and Seedling Growth of Barley under Conditions of P and Zn Deficiency

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Low input production of barley on the predominantly calcareous soils in most countries of West Asia and North Africa is affected by drought and a low availability of P and Zn. Especially during the early growth stages, P and Zn deficiencies retards seedling growth, rendering the young plantlets particularly sensitive to the frequently encountered dry spells. Seed priming (imbibition in water and drying back to storage moisture until use) has been shown to improve crop establishment and, in some instances, to increase crop yields. While increased seedling vigour will improve barley establishment, possible benefits are likely to be limited when P and Zn are deficient. A promising variation of the priming concept is the seed treatment with solutions containing the limiting nutrient. A series of experiments was conducted in a phytotron in 2003 to develop a nutrient priming approach to foster the establishment of barley under marginal growing conditions. Seeds of the tradition barley cultivar Arabi aswad were soaked for 0–48 hours in water, and for 12 hours in solutions containing 5–500 mmol P, Zn and P+Zn and dried back to 12 % moisture until further use. Seed were incubated at 10°C and germination was evaluated over a 6 to 8-day period. Additionally, growth and nutrient uptake of 4 week-old seedlings, grown at 25 and 100 % field capacity in a typical Xerosol from Syrian were evaluated. Water priming for 12 hours with subsequent seed storage of up to 9 weeks increased germination rate from 65 to 95 %, and advanced germination by up to three days compared to unprimed seeds. Addition of 10 mmol Zn and 50 mmol P to the priming solution increased the P and Zn content of the seeds without affecting germination. It furthermore significantly stimulated growth and P and Zn uptake by four week-old seedlings and improved the water use efficiency of drought-stressed plants by 44 % above that of unprimed seeds. On-farm validation experiments in Syria are currently on-going.

**Keywords:** Calcic xerosol, drought, *Hordeum vulgare*, nutrient priming, Syria

## Changes in Redox Potential, pH and Nutrient Uptake of Wetland Rice on Six Soils in Myanmar

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Rice (*Oryza sativa*) is the main staple food crop in Myanmar accounting for 97 % of total food grain production. Changes in redox potential and pH are brought about by flooding the rice fields, with influences on nutrient availability, which was the objective of this study.

4 soils from Lower and 2 soils from Upper Myanmar were used. As in Lower Myanmar rainfall (>2300 mm/a) is much higher than in Upper Myanmar (<1000 mm/a), usually the pH of these soils is lower (around 5.5) compared to the upper part of the country (about 8). 20 seeds of *Oryza sativa*, variety Manawthukha, were sown in pots in 400 g of each soil and grown under submerged conditions in a climatic chamber at 25°C and 12 h day light, with 4 replicates in a randomised block design. Eh and pH were measured every 7 days. 24 and 50 DAS, plants were harvested and yield as well as mineral uptake and plant concentrations of P, K, Na, Ca, Mg, Fe, Mn, Cu and Zn were determined.

In all 6 soils tested, Eh declined from 400–500 to 100–200 mV in the 50 DAS and submergence. The pH in the alkaline soils declined from 7.3 to 6.9, probably due to CO<sub>2</sub>-pressure increase produced by organic matter decomposition, while in the acid soils pH increased from 4.5 to 5.5 due to water logging and reduction of Fe, Mn and organic acids. On the high pH soils, yield was a lot lower than on the lower pH soils. On the different soils, all examined nutrients could be taken up in normal amounts by the rice plants, but on the high pH soils, probably due to precipitation as hydroxide, Mn concentrations were very low in spite of water logging, and Cu concentrations were very high, probably toxic. This could be the reason for the low yield on the high pH soils. Application of acid fertilisers and/or introduction of legumes in the rotation, being able to reduce the soil pH in the rhizosphere, is recommended.

**Keywords:** Nutrient uptake, pH, redox potential, wetland rice

## Evaluation of Residue Management in Irrigated Rice-based Systems of the Mekong Delta

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Agricultural land use in the Mekong Delta of Vietnam is dominated by intensive irrigated rice double and triple cropping systems on both alluvial and acid sulphate soils. A generally observed decline in productivity is linked on the alluvial soils to low N use efficiency and a low soil organic matter content. On the acid sulphate soils, rice production is constraint by nutrient imbalances such as iron toxicity and P deficiencies. Faced with the productivity declines, farmers increasingly diversify their cropping system. The most prominent diversification strategy is the replacement of the dry season rice by high-value horticultural crops grown under upland conditions. While short-term economic benefits may arise from these new systems, upland cropping on the alluvial soils is likely to further accelerate the mineralisation of soil organic matter and hence to exacerbate the problems of declining soil N supply. On the acid sulphate soils, an aerobic soil phase can result in Al toxicity and exacerbate the problem of P deficiency.

Organic substrates from decentralised waste/water management are widely available but are unlikely to be applied to lowland rice. However, high value crops that favourably respond to substrate addition will justify farmers' investment in organic fertiliser strategies. Organic substrates may help alleviate the problems related to a low soil organic matter content and may help buffer toxic Al. During the dry season of 2003/2004, the effect of the application of various types and rates of locally available waste products on the growth and nutrient uptake of cereal, tuber and vegetable crops was evaluated on both an alluvial and an acid sulphate soil site. The results from this research are seen to guide future substrate use in the rice-based systems in the rural areas of the Mekong Delta, through the development of a decision tool, providing site- and system-specific indications as to the expected effects that a given substrate/application rate is likely to achieve on a range of possible target crops.

**Keywords:** Nutrient cycling, organic waste, *Oryza sativa*, Vietnam

## Managing Soil N-dynamics in Rice-wheat Cropping Systems Along an Altitude Gradient in Nepal

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The rice-wheat annual double cropping system occupies some 0.5 million ha in Nepal along a gradient between the tropical lowlands of the Terai and the subtropical mid-hills of the Himalayas. Mineral N fertiliser use in the predominant smallholder agriculture is low and crops rely largely on native soil N for their nutrition. Alternating soil drying and wetting cycles stimulate N losses, particularly during the 1–3 months dry-to-wet season transition period (DWT) after the harvest of wheat and before the transplanting of rice. Soil N uptake by nitrate-catch crops grown during DWT, sole or in combination with wheat straw application (temporary microbial N immobilisation), has been shown to reduce N losses and to significantly increase rice yield with residual yield effects on the subsequent crop of wheat. However, the choice of DWT crops needs to be matched to farmers' preferences and to the different climatic conditions prevailing in the agroecological zones of Nepal where rice and wheat are grown. The feasibility and the adoption potential of options vary along the altitude gradient (length of DWT, seasonal temperate variations) and by farmer's resources and production objectives (food preferences, alternative uses of straw, market access). Field experiments were conducted on farmers' fields at three sites along an altitude gradient in Nepal between 2003 and 2004. The sites included the temperate highlands at 2000 m altitude, the subtropical foothills of the Himalayas at 600 m altitude and the (sub)-tropical lowlands of the Terai. Technical options comprised a wide range of "nitrate catch crops", several nitrogen-fixing green manures and various rates of wheat straw, applied sole or in combination with the transition season crops. Key findings on soil nitrogen dynamics and performance parameters of rice and wheat will be presented. Computer-based decision tools are being developed to provide a quantitative base for improved cropping calendar planning and the identification of target areas for site-specifically-adapted crop options.

**Keywords:** *Mucuna*, *Oryza sativa*, *Triticum aestivum*, Vigna

## Disease Control in Certified Cacao Production Systems in the Alto Beni — Bolivia

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Cacao (*Theobroma cacao*) is produced by a small farmer association —El Ceibo— in the Alto Beni — Bolivia. These producers depend largely on cacao for their income. In order to promote export of their produce, based on the demand for sustainable and organically produced cacao, farmers have adopted organic certification. No chemical herbicides, insecticides or nematicides are used. However, organic cacao production techniques are difficult to implement and average yields are low compared with conventional cacao.

As a result of high humidity, fungal diseases result in serious yield reductions. Abandoned or mismanaged cacao plantations act as sources of inoculums and there is little cultural control and pruning in productive areas. Previous experiences in others cacao-producing countries have shown promising results from multi-strata canopy management and organic soil fertility maintenance. The use of antagonistic microorganisms for biological control as part of an overall Integrated Pest Management strategy of cacao diseases is given good results. Optimal use of cocoa germplasm and development and distribution of improved pest and disease resistant varieties of cocoa planting materials are only beginning to be explored in the region.

In this study we identified the effects of tropical diseases in cocoa plantations under organic, conventional and agroforestry. Cacao groves were classified according to their management regime. Diseases were characterized and quantified. Most damage was caused by pathogenic fungi, *Phytophthora* sp. and *Crinipellis pernicioso*. Continuous removal of diseased pods reduces disease incidence significantly. With this information, we compare strategies toward ecologically and economically sustainable cacao production on small farms.

**Keywords:** Agroforestry, Bolivia, cacao, certification, *Crinipellis* sp, diseases, *Phytophthora* sp., *Theobroma cacao*

## **Timber-stand-improvement through Early Thinning Operations in *Acacia mangium* WILLD. Plantations in Roraima, Brazil**

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The pioneer species *Acacia mangium* Willd. is planted pan-tropical for timber and fibre production. In Roraima, increment ranges widely between 4 and 30 m<sup>3</sup>/ha/yr depending on treatment and site conditions. Anticipated rotation cycles are around 15 years for timber production. In the savannahs of northern Brazil (Cerrados) around 15,000 ha of timber plantations have been established for sawlog production. Regularly inventories showed that crown cover closes at a basal area of around ten m<sup>2</sup>/ha independent of age. Thus, conservative approaches where thinning operations are planned according to top height or age had to be rejected and two methods have been developed solely based on stand quality and basal area.

- The positive selection of potential crop trees (pct) is carried out in stands with higher quality stems. There, pct's are marked and subsequently direct competitors are removed.
- The negative selection is implemented in stands showing lower stem qualities or where quality is not yet sufficiently differentiated. There, solely damaged, forking or multiple leader trees are removed.

The objective of both measures is to improve average stand quality for sawlog production and to maintain trees showing good growth performance, evenly shaped crowns and no signs of biotic and abiotic damages.

PCT stands were thinned at an average basal area of 12.4 m<sup>2</sup>/ha. Stand volume was reduced from 82.4 m<sup>3</sup>/ha to 64.1 m<sup>3</sup>/ha. Negative selection was carried out in stands showing 10.2 m<sup>2</sup>/ha. There growing stock was reduced from 60.3 m<sup>3</sup>/ha to 47.9 m<sup>3</sup>/ha. Both stand types comprised of 1378 stems/ha. After thinning, PCT stands comprise of 1126 trees whereof 364 trees fulfil the criteria of a potential crop tree. In stands where thinning was implemented solely through negative selection, stem number was reduced to 1143 trees.

The second thinning is scheduled when stand have reached around 16–18 m<sup>2</sup>/ha.

**Keywords:** *Acacia mangium*, silviculture, thinning, timber-stand-improvement

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## Rural Poverty Reduction through Better Field Technologies

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Better field technologies are the key for the technological progress in developing countries by improving revenues of farmers. Extension service lacks methods and tools how to improve its functions na help farmers make more profit from their farming activities. A new methodological approach was conceived in the concept of ATMP (Agricultural Technology Management Program) and has proved its appropriateness for extension service in both developed as well as less developed countries. The Program is meant to provide the art of work to the extension worker in providing sound and exact technological advice based upon both the availability of technological information (particularly on machinery sets and agronomic requirements) and rapid economic (costs) calculations. The programme demonstrates an attempt to put into practice the concept of “appropriate technology” with much sustainability based on (especially) precision machinery (animal draught and tool) inputs. It has only recently been completed and its comprehensive testing has commenced. Preceding field survey carried out in Zambia (August–September 2003) supplied basic data for technologies design and economic calculations. Four different technologies were conceived on various technological levels: 1. Hand-tool, 2. Mixed-hand-tool + animal draft, 3. Mixed-hand-tool + animal draft + mechanized and 4. Purely mechanized technology. All technologies were designed for Zambian conditions. The economic appropriateness of the respective technologies has been assessed according to the main parameters of the crop budget that were selected for export to the comparison table. The parameters included in the comparison table were displayed in table as well as chart forms. This enabled to a better comparison different parameters of the technologies. The main economic indicators that have been considered are the gross and net margins and own market prices per ton of the product.

**Keywords:** Agricultural technologic management programme, appropriate technology, crop budget, hand-tool technology, mixed technology, sustainable technology

## **The Situation of Coffee Growers in Ethiopia — Current Status and Perspectives for the Future Development**

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The collapse of world coffee prices is contributing to an economical and societal decline affecting an estimate of 125 million people worldwide. Ethiopia is the biggest loser with a fall in farmer and government revenues amounting up to 42 % within a year. During a one-week visit of the country leading to some major coffee growing regions (Awassa area, Jimma area) intensive discussions on coffee production and marketing with farmers, advisors, traders and researchers were held. The unanimous conclusion was drawn that Ethiopia has a big potential to produce certified organic high quality coffee due to the favourable growing conditions and the high diversity of genetic resources in the country of origin of *Coffea arabica*. Currently coffee farmers try to convert to organic production, e.g. the ‘Oromia Coffee Farmers Cooperative Union’ in order to obtain higher revenues. However conversion to organic coffee production may result in a significant decrease of crop productivity. Therefore various agronomic research is needed. A key focal point is efficient nutrient management by composting coffee husk and by sowing suitable legume-based green manures. Moreover a systematic screening of cultivars with respect to potential use in organic coffee production is needed. Aspects of taste and quality of coffee deserve special attention as well. Agronomic research on sustainable organic coffee production systems is expected to result in production and promotion of high quality (Q0) fair traded organic coffee as a motor for rural development in Ethiopia. In the presentation some major impressions of current coffee production in Ethiopia will be reported and an outlook on future research activities currently under preparation will be given.

**Keywords:** Coffee crisis, production of high quality organic coffee, Ethiopia

## **Einfluss von organisch-mineralischer Düngung auf Wachstum und Ertrag von Tabak (*Nicotina tabacum* L.)**

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Der Düngung des Tabaks wurde in Kuba in den letzten Jahren nicht genügend Beachtung geschenkt. Ziel einer Düngeempfehlung muss sein, die benötigten Nährstoffe effizient zu nutzen. Zu niedrige Düngung reduziert Erträge und Qualität, zu hohe Düngung ist teuer, wirkt sich negativ auf Qualität aus und belastet die Umwelt. Um den Einfluss verschiedener Düngung auf Wachstum und Ertrag von Tabak zu quantifizieren, wurde im Jahr 2003 ein Parzellenversuch mit den Tabaksorten „Habana-92“ aus Kuba und „Dreta“ aus Deutschland auf dem Standort Berlin-Dahlem angelegt. Die Düngungsvarianten waren Stallmist, NPK - Düngung und Stallmist + NPK-Düngung. Der Versuch wurde als einfaktorielle Blockanlage mit vier Wiederholungen angelegt. Zur Ertragserfassung wurden mehrere Blatternten und eine Ganzpflanzenernte durchgeführt. Die Sorten unterschieden sich deutlich im Morphologie, Blattfarbe und Wachstum. Die Sorte Habana-92 hatte eine wesentlich dunklere Blattfarbe und kleinere Blätter, entwickelte sich trotz der anderen klimatischen Bedingungen gut. Die Blattanzahl war bei beiden Sorten etwa gleich groß. Im Vergleich der deutschen und der kubanischen Tabaksorte wies „Dreta“ einen signifikant höheren Frischmasseertrag auf als „Habana-92“. Hinsichtlich des Trockenmasseertrages ergaben sich jedoch nur geringe Unterschiede. Der mittlere Trockensubstanzgehalt der Sorte Habana-92 lag fast doppelt so hoch wie bei der Sorte Dreta. Mineralische NPK-Düngung hatte einen stärkeren Einfluss auf das Wachstum und den Ertrag von Tabak als ausschließliche Stallmistdüngung. Der Einfluss der Düngung auf den Ertrag war bei der Sorte Dreta stärker ausgeprägt als bei der Sorte Habana-92. Die höchsten Erträge wurden in der Variante NPK - Düngung + Stallmistdüngung erzielt.

Zwischen bodenbiologischen bzw. -chemischen Parametern und dem Wachstum bzw. dem Ertrag von Tabak ergaben sich nur schwache Beziehungen.

**Keywords:** Düngung, Ertrag, Tabak

## Hydroponics Technology in Urban Iquitos, Peru

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The main Peruvian city on the Amazon River is Iquitos. Iquitos with its 400,000 inhabitants may be the largest city in the world that cannot be reached by automobile. The city is located on an island surrounded by the Amazon and its tributaries. During wet season the Amazon River can rise as much as 40 feet from its lowest point. When the Amazon reaches its maximum height, the force of the water will cause the tributary rivers to actually flow backwards, causing much of the arable land to flood. Therefore crops can be grown only for a short duration every year, resulting in a shortage of food, especially high value crops for the poorer segment of the urban population. Hydroponics can help to overcome this shortage, enabling small scale farmers and communities to produce crops high in nutrition in spaces unsuitable for conventional agriculture.

In 2003 an national project to develop hydroponic technologies for small scale farmers peri-urban to Iquitos started. Goal of the project was to test and establish different technologies based on locally available materials as well as the promotion of such technologies among different communities. The project was set up as farmer participatory research program. Additionally hydroponics gardens were established in school gardens. The establishment of such technologies in school gardens enables the implementation of technologies and research in the national educational curricular. In farmer field schools the best technologies for production of high value crops are promoted. Socio-economic studies were conducted to study the projects impact to local farmers supplying food to Iquitos and its peri-urbane areas.

**Keywords:** Farmer field schools, hydroponic, Iquitos, Peru, urban horticulture, vegetable production

## Management of Nutrient Fluxes for Barley Production in Northern Syria

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The Khanasser valley is located at the border of the agricultural area and the steppe of Northern Syria. It serves as a benchmark site for an integrated research in the dry areas in Western Asia and Northern Africa, conducted by ICARDA, BMZ/GTZ and the University of Bonn. Low soil fertility (pH > 8.3, P < 4.1 mg kg<sup>-1</sup> Olsen, Zn < 0.5 mg kg<sup>-1</sup>), inadequate rainfall (200–250 mm), monocropping, high weed infestation, and emerging land shortages limit the widespread production of rainfed barley as animal feed (sheep fattening) in the valley bottoms at low external input use. In 2004 we studied the interactions among soil moisture, nutrients availability, and natural resources management practices on barley production in relation to land use and physical characteristics of the valley slopes.

The dynamics of soil moisture (TDR) and nutrient availability (ion exchange resins) in barley plots were monitored as a function of the distance from the slope (10, 25, 100 and 200 meters). Partial nutrient flows in the farming system (crop, household and animal husbandry) were analysed using PLAR approaches (Participatory learning and action research - a kit for resource flow as an investigation tool). Finally, the effect of low-input nutrient management options (seed priming with water P/Zn; mineral P application at 60 kg ha<sup>-1</sup> and the use of animal manure at 2 t ha<sup>-1</sup>) on nutrient balances and barley performance were evaluated at field level. The effectiveness of technical options will be assessed in relation to physical characteristics of the valley and socio-economic determinants of the households.

**Keywords:** *Hordeum vulgare*, nutrient management, phosphorus, seed priming, zinc



## Subsession 3b: Application of Plant Modelling

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## Crop Modelling — What Has It Achieved and Where Is It Going?

ROBIN MATTHEWS

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The greatest use of crop/soil models so far has been by the research community, as models are primarily tools for organising knowledge gained in experimentation. The use of models in decision-support systems has had major impacts in the areas of irrigation scheduling and pest management, although this has been more as heuristic tools rather than operational systems. Models have a useful role to play as educational tools, both as aids to learning principles of crop and soil management, and also in helping students to develop a ‘systems’ way of thinking. However, crop modelling as a research area is at a cross-roads; mathematical representations for most of the major crop processes have now been developed, and, although there is scope for further refinement of some of these, this is unlikely to contribute significantly to improving the accuracy and reliability of the models at the crop level. It is suggested that there are two opposite directions in which crop modelling research can develop.

In one direction, the rapidly expanding field of genomics means that links between information at the gene level and performance at the phenotype level need to be established, and models developed to describe these. Such models could help to improve the efficiency of crop improvement programs by providing more efficient ways of identifying and evaluating desirable plant characteristics.

In the other direction, crop models can be incorporated into higher-order systems such as the whole farm, catchment or region. At one level, linking crop growth models with other physical process models, such as those describing soil processes influencing gaseous emissions, for example, is a logical next step, and is occurring to some extent already. At another level, the role of humans in these systems also needs to be made explicit, so that the decisions that they take to sustain and improve their livelihoods and the influence these have on their environment can be taken into account. For both levels, ways must be found of incorporating knowledge from such diverse fields as agronomy, soil science, livestock, sociology, economics, artificial intelligence, and policy-making into workable and realistic simulation models.

**Keywords:** Crop modelling



## **Modelling Early Growth and Carbon Sequestration of Fast Growing Teak (*Tectona grandis* LINN. FILL.) as a Tool for Land Management in Indonesia**

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Forest degradation in Indonesia is mainly caused by land use change and logging. This is accelerated by slash-and-burn practices of poor farmers, economic turmoil and high demand for wood. One approach to reduce forest degradation is to cultivate trees which have economic and ecological value such as fast growing teak (*Tectona grandis* LINN. FILL.). However, information on growth response of this kind of teak to environment is very limited. The objective of the research is to calibrate a simulation model that can describe the relationship between fast growing teak growth and soil water availability, one of the important factors which has a high variability in Indonesia. The model can be used for zoning, risk analysis, and land management.

The research consists of a modelling project and a field experiment to obtain model parameters. The field experiment was conducted for two years in Java, Indonesia with three levels of irrigation: control (0), 7 and 14 mm/day to reflect varying seasonal water regime. The measurements included phenology, growth, climate variables and soil water content. The model consists of three sub-models, i.e. phenology, growth, and soil water balance.

The results show that soil water availability is a very important limiting factor for the early growth of fast growing teak. Strong water stress led to missing plants due to wilting. Irrigation produced higher tree volume and biomass than control. However, 14 mm/day was not significantly different from 7 mm/day. Rates of leaf emergence and leaf drop are affected by water availability. Water stress delayed leaf emergence and accelerated leaf drop. Carbon content in plants was not affected by water availability.

Preliminary results from simulation runs show that the calibrated model describes the dynamics of early growth and carbon sequestration but needs further validation.

**Keywords:** Carbon sequestration, decision support, fast growing teak, Indonesia, simulation model

## Modelling Conservation Agriculture

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Conservation agriculture (CA) is a general term for a series of resource-conserving agricultural practices. Minimum or zero-tillage combined with crop residue retention and crop rotation are the fundamental components of CA. Additionally, alternative planting techniques such as permanent raised-bed systems are often applied in CA. These components add complexity to the cropping system, which challenges the applicability of commonly used crop-soil simulation model. But also the effects of conventional soil tillage, such as the temporal decrease in soil bulk density and increase in water infiltration capacity as well as mixing of soil layers, i.e. of texture, organic matter and nutrients, are often not accounted for in crop-soil simulation models or are represented in a limited way. In classical model applications this lack may be of little relevance. However, when models are used to explore the crucial differences between CA and conventional agriculture, changes in and effects on soil properties due to one or the other practice becomes highly relevant. This paper reviews how soil properties are affected by CA and conventional tillage. A modified version of the DSSAT (Decision Support System for Agrotechnology Transfer) model is described that includes several routines to account for the impact of tillage and surface residue retention.

Initial applications show that in the presence of a surface residue layer the classical SCS curve number approach fails to describe surface runoff adequately, because the residue layer increases surface roughness and retains water, which is not accounted for in the SCS approach. Also, in the presence of a residue layer soil evaporation is lower leading to comparably higher topsoil moisture content and consequently to a higher runoff according to the SCS curve number method. The one-dimensional cascade approach used by the model to simulate soil water infiltration and drainage does not adequately capture the soil water redistribution in raised-bed cropping systems. Modifications are needed to account for these two processes.

**Keywords:** Crop modelling, crop residues, soil water dynamics, tillage

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## **Modelling Concepts for Sodium and Potassium Distribution in Salt-stressed Irrigated Rice — Getting Closer**

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Rice genotypes subjected to salt-stress can develop several mechanisms to cope with salinity. Atmospheric conditions modify the efficiency of most of those mechanisms. Germplasm improvement programs have to take environmental conditions such as temperature, humidity or day length into account when selecting for salinity resistance. Factors influencing the level of salinity resistance are exclusion of sodium, selective uptake of potassium, high tissue tolerance for sodium, establishment of high K/Na ratios in photosynthetically active tissues, maintaining viable leaves, retention of sodium in physiologically less important tissues and more. Many of these factors depend on the amount of water passing through the plant passively carrying the sodium load into the plant. The amount of water passing through the plant is a function of transpiration and thus stomatal conductance. Stomatal conductance can be directly influenced by the number of stomata per surface and the stomatal aperture, which in turn is directly influenced by, nitrogen concentration in the leaf, VPD, temperature, and the hormonal status of the plant.

In order to avoid enormous field or greenhouse trials to test all possible combinations of mechanisms and their responses to climate, simulation modelling can be employed to create a large number of scenarios. In recent years our group has developed a concept model for sodium and potassium uptake and distribution in rice, which depends mainly on factors influencing transpiration for sodium uptake and distribution and assuming energy consuming active uptake and (re)distribution of potassium. This model has worked well as a static model, however, in order to be used as a tool for genotype development, the model needs to be dynamic and responsive also to salinity influences on growth parameters such as leaf initiation and carbon partitioning. This contribution will summarise the concept as it is now and show some of the underlying principles of the transpiration driven sodium distribution, stress independent simulation of leaf appearance and the influence of the potassium concentration in different tissues on the sodium retention level of these tissues. Problems of up-scaling will be discussed.

**Keywords:** Rice, germplasm, modelling

## Using Simulation Modelling to Evaluate the Efficacy of Strategies to Control the Parasitic Weed *Orobanche crenata*

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Infestation with the root parasite *Orobanche crenata* FORSK. is one of the major biotic factors limiting profitable legume production in the Mediterranean countries. Complete yield loss can occur in the affected crops. The fertility of the parasite can lead to rapid build-up of an abundant seedbank representing a devastating infestation potential. Efforts to develop effective and practicable control methods had limited success due to the complexity of host-parasite interactions. Hence, the combination of several control approaches in an integrated strategy seems most promising. Experimental evaluation of all possible control strategies is not possible because of temporal, spatial and financial constraints.

The use of an eco-physiological model can help predict the efficacy of potential control strategies and improve the efficiency of field experimentation. Crucial aspects of host-parasite interactions include biomass partitioning among the two organisms in the short, and population dynamics of the parasite in the long term; thus, these are the most important aspects to be included in a model. A mechanistic competition model of the association faba bean – *O. crenata* was developed using field data from Syria and integrated into the framework of the cropping systems model APSIM (Agricultural Production Systems SIMulator). The model was evaluated using independent data sets from Turkey and enhanced by a component for simulating *O. crenata* seed bank dynamics. In the evaluation, APSIM proved capable to realistically reproduce courses of host and parasite growth and development. The evaluated parasite module was then used in a series of simulation studies to assess effects of tactical and strategic control measures. The model predictions were found to be in good accordance with reported field observations, where such information was available. Furthermore, they facilitated the quantitative evaluation of potential control strategies.

Further steps shall include improving the model by integration of a spatial component and expanding its scope to other biotic factors.

**Keywords:** Eco-physiological model, *Orobanche crenata*

## **Biomass Estimation Techniques for Enclosures in a Semi-Arid Area — A Case Study in Northern Ethiopia**

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For centuries, land degradation triggered by deforestation has occurred in Ethiopia, in particular in the northern regional state Tigray, the area under study. In order to change this situation, the local government started to establish enclosures. In these sites, grazing is no longer permitted so that forest can naturally regenerate. In order to develop sustainable yield planning for forest rehabilitation areas in Tigray, one needs to know the effect of closing areas on biomass accumulation. In an enclosure, above-ground dry weight of herbaceous and woody species was estimated at 1,84 ton/ha. A combination of destructive and non-destructive methods was tested. The non-destructive study was rejected because of a non-accurate wood density estimation, and low correlation coefficients for the weight predicting models. Best fit-least square regression models were developed using diameter at 30 cm height as the independent variables and dry weight as the dependent variable. Coefficients of determination for the selected total biomass models non-destructive study. Equations for foliage biomass generally had lower coefficients of determination than the equations for either stem or total biomass of the woody species. Non woody biomass was measured in different enclosures in order to estimate the biomass production in function of the management technique. 98% of the total herbaceous biomass of the sampled grass plots belonged to *Hypperrhenia hirta*, while in the grazing land nearby it was only 11 %. The correlation coefficient between grass biomass and basal area of the woody vegetation was -0.11. Based on this study this enclosure is not adopted for fuelwood collection.

**Keywords:** Biomass yield, closed areas, destructive study, *Hypperrhenia hirta*, non-destructive study

## **Simulation and Validation of Modelled Water Use and Biomass Production of Natural Plants in the Draa Valley (Southern Morocco) — A Case Study of Impetus Testsite Taoujgalt**

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Southern Morocco is a semiarid, heavily grassed region with a long tradition of transhumance activity. The spatial ecosystem model SAVANNA, developed by M. COUGHENOUR, is being used to model ecosystem dynamics and to gain knowledge about the thresholds of sustainable use in this region. Within SAVANNA different functional groups of vegetation are defined to simulate plant growth and plant competition for nutrients and water. In addition, biomass intake by animals and the movement of herds are simulated.

Parameterisation and calibration of the SAVANNA model for the Draa watershed as well as first simulation results will be presented, considering sheep, goats and camels as the most abundant animals. For the plant part of SAVANNA, transpiration measurements as well as biomass determination are being used, which were carried out in the years 2001–2003 in order to achieve an estimate of the plant influence on the hydrological circle of this water catchment. Intensive measurements took place in a characteristic rangeland area of the northern Draa valley at Taoujgalt (1900 m a.s.l.), located at the southern slope of the High Atlas mountains with a homogeneous plant cover. The dominant perennial species are *Artemisia herba-alba* and *Teucrium mideltense*.

Biomass production and plant transpiration in this region are less linked to local precipitation, and may even exceed precipitation. This indicates the influence of local water storage in the soil, and/or the influence of groundwater fluxes within this mountainous region. As well it is important to comprise that the groundwater level of this area strongly depended on local precipitation, due to the well irrigation systems of farmers in the northern part of Taoujgalt area.

**Keywords:** Biomass, desert, plant modelling, precipitation, south Morocco, transpiration rates, water use

## Crown Structural Indicators in a Natural Mixed Coniferous Forest in Northeastern Mexico

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This study presents the results of indicators for the crown structure of a natural, uneven-aged forest (*Abies vejari*, *Pseudotsuga menziesii*, *Pinus ayacahuite* and *Pinus hartwegii*) at the Cerro El Potosí at 3100 m.a.s.l in the Sierra Madre Oriental, Nuevo León, México. Position, age, diameter, height, basal area and crown parameters of 504 trees were measured in this area. There is a wide variability in age, height and diameter of species due to the fact that the forest is uneven-aged and mixed. Tree distribution diameter classes and height zones are calculated from the data to show the population structure. The Weibull bimodal distribution was applied to determine the diametric distribution of coniferous species, determining the presence of two strata in their vertical structures (high zone I and II). Several crown indexes (crown width index, crown thickness index, crown spread ratio, crown projection area and crown surface area) were used. For the description of specific crown properties related to the tree species, the crown thickness index and the light crown percentage (light crown length/crown length) were found to be quite adequate. The variation of these indexes is surprisingly high even within the same tree species. Finally, the ratio between the crown surface area regarding the surface area of the light crown and the crown projection area differs greatly between the four tree species. According to the heterogeneous structure of the uneven-aged and mixed stand a large variability in stem dimensions and crown parameters was observed. In conclusion, the uneven mixed stands present a specific structure, thus making the method of evaluation developed here reliable, being of high value for forest ecosystem management plans, where forest structure is considered to have a high priority. This study was financially supported by Consejo Nacional de Ciencia y Tecnología, México, through the project: Caracterización Estructural del Estrato Arbóreo en Bosques Multicohortales del Norte de México: 333919—B.

**Keywords:** Crown index, Mexico, mixed forest, uneven-aged stand, Weibull distribution

## Development and Validation of a Temperature-based Simulation Model for the Potato Tuber Moth, *Phthorimaea operculella*, ZELLER

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The potato tuber moth (PTM), *Phthorimaea operculella* ZELLER, is a serious pest of potatoes in tropical and subtropical regions. Knowledge of temperature-dependent population growth is crucial for understanding PTM population dynamics and implementing control strategies in different agro-ecological zones. We studied the development, mortality of immature life stages, and reproduction of PTM at constant temperatures in the range of 10–32°C. Theoretical developmental thresholds were 11, 13.5, and 11.8°C, and required incubation times were 65.3, 165.1, and 107.6 degree-days for the egg, larval, and pupal stages, respectively. Population parameters were best described by using the following models: nonlinear low-temperature development of immature life stages — four-parameter version of the SHARPE & DEMICHELE (1977) model; stage specific development frequency — lognormal cumulative distribution function; mortality of immature life stages — second-order polynomial function; adult senescence — SHARPE & DEMICHELE model; total fecundity — polynomial function; age related cumulative proportions of fecundity — cumulative gamma function. The established functions were used to develop a *P. operculella* population model using the rate-summation approach. Life-table parameters were simulated over a range of temperatures and calculated values gave good predictions when compared with published data. Population increase occurs within a temperature range of 10–35°C (optimum at 28–30°C).

Field research on population dynamics of PTM and life-cycle studies were conducted under various agro-ecological conditions in Peru, Egypt and Kenya. These life-table data obtained under fluctuating temperatures were used to validate the temperature-based simulation model which gave good predictions for each site. Possible uses of the model to predict critical field infestation periods and as a decision-making tool in Integrated Pest Management of PTM are discussed.

**Keywords:** Life-table statistics, *Phthorimaea operculella*, population dynamics, potato pests, potato tuber moth, temperature-dependent development rate models

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## Using the Economic Surplus Method to Assess Economic Impacts of New Technologies — Case Studies of EMBRAPA

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Assessment of economic impacts of new technologies delivers very helpful information to justify investment efforts in research and development to generate new technologies. In Brazilian agricultural research and development, it's a convention to assess economic impacts of technologies generated and adapted by EMBRAPA. As soon as new technologies are adopted, ex-post assessment is conducted to evaluate net benefits of its adoption. In agricultural research, the economic surplus method represents one of the suitable frameworks to measure the aggregated social benefits of a research project. With this method it is possible to estimate the return of investments by calculating a variation of consumer and producer surplus through a technological change originated by research. Therefore, in a first step, the gain of adoption i.e. increases in productivity, quality improvements, cost reduction, etc. is estimated. In a second step, the costs involved in generation and adaptation of the technology are enumerated. The difference between the gains and the costs of generation and transfer represents the net benefit of the technology, explained by the net present value, the internal rate of return and the benefit-cost-ratio. The so far obtained results serve as additional information for each technology to improve its adoption by beneficiaries and to enable access to new financing sources. Some examples of such technologies are **(a)** the finishing of lambs in confinement in the Brazilian semi-arid Northeast during the dry season, when feeding resources are scarce and the lamb meat prices are high, **(b)** strategic vermifugation of goats herds and sheep flocks in the Brazilian semi-arid areas, **(c)** standardized cuts for goat and sheep carcass and nd sheep flocks in the Brazilian semi-arid areas, **(c)** standardized cuts for goat and sheep carcass and enrichment of the native pastures in Brazilian Northeast with *Cynodon dactylon* for sheep production. The assessment of the economic impacts of these technologies estimated positive net present values for all four considered technologies, internal rates of return of 26.2 % (a), 13.8 % (b), 52.8 % and 31.0 % (d) and benefit-cost-ratios of 2.92 (a), 1.19 (b), 11.64 (c) and 3.37 (d).

**Keywords:** Agricultural research, economic impact assessment, economic surplus method

## Climate Change and Optimal Farming Strategies in Semi-arid Southern Africa

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Climate change is a fact. At least from a farmer's perspective declining annual precipitation and higher rainfall variability is a challenge for viable farming strategies in the semi-arid region in Southern Africa. In Central Namibia cattle and game farmers face rangeland degradation. Above all, bush encroachment leads to a severe loss of pasture production potential. A local farming system with respect to both the economic decision making and the responding dynamics to natural pasture dynamics was investigated with the use of ecological-economic models. Hereby innovative technologies like new bush control measures were considered. To predict agro-ecological response and future farm developments, three different rainfall scenarios have been simulated. Within the simulation model rainfall is a stochastically appearing input factor. Main results of climate change are more extreme rainfall events. Therefore generated rainfall scenarios are based on a reduced mean precipitation (10 %, 20 % and 30 %) but at the same time increased standard deviations (again 10 %, 20 % and 30 %). At a 10 % rainfall scenario, farm development does not significantly change when compared with an extrapolation of the current precipitation. At the 20 % (and 30 %) rainfall scenario, the picture changes drastically. Farmers would face less biomass production and higher risk and uncertainty. This has an impact on optimal farming strategies. Due to risk and decreasing productivity, investments in rangelands (sustainable farming techniques) get less attractive. In particular, investments in bush control do not pay anymore. This is even true for the new application of controlled bush fires although this is a rather "cheap" tool. As a consequence bush encroachment increases as future returns become uncertain. In fact, at climate change beyond the ecological/economic threshold (at the 20 % rainfall-scenario), an optimal farming strategy would rather be to extract "the natural assets" quickly. As further simulations have shown, actual farming strategies also depend on the degree of indebtedness, labour costs, interest rates etc.. All in all, profit-seeking farmers might amplify the natural impact of climate change. This would lead to a self-enforcing mechanism of degradation as being dependent on risk.

**Keywords:** Climate change, farming strategy, livestock, model, Southern Africa

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## **Herd Mobility Leads the Way for Sustainable Pastoral Development — The Case of Borana Rangelands, Southern Ethiopia**

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Insights gained from experiences in pastoral development highlight mobility as the key strategy by which pastoralists exploit heterogeneous environments in space and time. Mobility is customarily organised against the background of indigenous knowledge and local decision making structures. Modern development concepts as well as government interventions have changed considerably over the past decades, but the impact on ecosystems and livelihood conditions remained small or became deteriorating. A new approach is needed, which utilises indigenous mobility concepts and institutional co-operation in natural resource management. This paper develops concepts for the participatory planning of pastoral resource use on two sites in southern Ethiopia (Dida Hara and Web), which have been affected in different intensities by government interventions, and by a higher population density. The study was conducted from September 2000 until July 2002, in co-operation with the Borana Lowlands Pastoral Development Programme (BLPDP/GTZ). Natural resources and herd movements were mapped using PRA tools, official maps and GIS. Socioeconomic characteristics of 60 households and their herd movements during and after the last drought were analysed. Herd mobility differed between the two locations: after drought it was barely existent in Dida Hara, the location more strongly affected by development interventions, but pronounced in Web. Mobility during drought was similar at both locations, as herd movements were driven by the crisis. The socio-economic analysis determined preconditions for applying mobility at household level, specified for different stages of the drought cycle. The complementary analysis of pastoral organisations and institutions involved in controlling mobility revealed the existing local expertise and viable social structures, but also weaknesses in power structures and related conflicts. The results of final multi-stakeholder workshops affirmed that mobility was under-utilised. A revitalisation of mobility should be attempted with the genuine involvement of the appropriate target groups and their experience. Envisaged are scenarios of rangeland management which operate preferably in a common property context at larger scale of the landscape. This approach integrates technical aspects of pastoral development with predictions about the household's adoption rates and viable institutional arrangements, making it more tangible and target-oriented than development concepts and policies could achieve so far.

**Keywords:** Common property natural resource management, development, indigenous knowledge, mobility, pastoralism

## Comparison of Urban and Peri-Urban Dairying in Awassa, Ethiopia

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The aim of this study was to compare urban and peri-urban dairy production systems in Ethiopia. Awassa town was compared with its peri-urban area Loke, and the peri-urban areas of two adjoining towns: Leku and Yirg'Alem. One hundred and twenty-four dairy farms were studied comprising 60 farms in urban and 64 in peri-urban areas. The farms were stratified into small (< 3 cattle), medium (4–9 cattle) and large ( $\geq 10$  cattle) based on initial survey. Animal production and socio-economic data like milk yield, feed costs, access to markets and milk sales were collected using questionnaire. Eighty crossbred cows (320 udder quarters), 50 from the urban area and 30 from the peri-urban area were selected from 26 farms in urban and 23 farms in two of the peri-urban areas excluding Loke, and tested for mastitis. In addition, 177 cattle were screened for *Brucella* antibodies in Awassa and Loke. The urban producers spent on average Birr689.59/month on feed, amounting to Birr100.67/cow/month, while their peri-urban counterparts spent Birr97.06 and Birr15.57 respectively. The lactation yield in the urban area was 1489.6l per local cow and 3949.6l per crossbred cow, while in the peri-urban area, the lactation yield were 444.4l and 2596.2l respectively. While the urban producers sold 80 % of total milk produced, the peri-urban producers sold only 35 %. There was a prevalence of 51 % sub-clinical mastitis (SCM) in peri-urban farms which was significantly higher than 39 % SCM found in urban farms ( $p < 0.05$ ). There was a prevalence rate of 4 % in 102 cattle sampled for *Brucella* in Loke, while no positive result was found in 75 cattle tested in Awassa. The study showed that there is a considerable potential for dairying in Awassa and its surroundings. Although the peri-urban producers face unavailability of market outlets for selling their milk, they benefit from availability of forage and the cow dung used as manure. Producers in Awassa spent money to get rid of their cow dung, faced shortages in feed, but benefited from nearby milk customers. Improving logistics like transportation and building up organisational links between farmer groups will lead to both production systems benefiting from each other.

**Keywords:** *Brucella* antibodies, crossbred cows, lactation yield, peri-urban dairying, sub-clinical mastitis, urban livestock production

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## Keeping Cattle in the Brazilian Eastern Amazon — Constraints on Improving Smallholder Management

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Exotic large ruminants have been kept on flood plains and riversides of the Brazilian rain forest since the 17<sup>th</sup> century. Their incursion onto the non-flooded areas is recent. New settlers to the Amazon region were encouraged with financial incentives, particularly during the 1970s, for politico-strategic reasons. Initially, large ranchers were the main beneficiaries of official settlement programmes. Then the droughts in the Northeast and land shortages in the South triggered the migration of poorer people who became smallholders in the North. The new environment was very different from the places they had left. Some of these small farmers started to adopt the cattle keeping activities of the large-scale neighbours. Credit lines were launched supporting the purchase of cattle and the building of fences. In the development agenda, no differentiation was made between smallholders and ranchers. The non-flooded areas were covered by rainforest, which had to be slashed before any cultivation of pastures could start. The re-growth of the secondary vegetation competed with the introduced pasture plants for space and scarce soil nutrients. This paper examines the specific limitations for improvement of cattle production imposed by the smallholders' overall farming system. For 15 months thirty-seven smallholdings with cattle were visited monthly in order to draw a realistic picture of the whole farm system. Smallholders in the Bragantina study region kept an average of 14 head mostly for beef production, but their main enterprise was cropping: two competing land uses within one system. Whereas ranchers had at their disposal surplus funds to modify the environment, smallholder pastures were established with family labour in competition with economically more important cropping activities. Problems of adequate pasture establishment and maintenance were aggravated by the smallholders' lack of capital and specialised knowledge. Furthermore, their cattle served mainly as a means of financing, rather than production. Consequently, husbandry was hardly ever being based on long-term planning or on continuous keeping. Sales and purchases of complete herds were observed in a quarter of the farms studied. Therefore, farm advisers need to consider the low-input character of cattle keeping and focus on the prevention of ecological degradation of pasture.

**Keywords:** Brazilian Amazon, cattle, production conditions, smallholder, systems approach

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## **Supplementation of Maiden Does in Late Pregnancy and Early Lactation to Increase Colostrum and Milk Production to Enhance Kid Growth and Capretto Quality to Increase Profits**

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This research was conducted to test the general hypothesis that supplementation of maiden does for one week before kidding would increase colostrum and milk production, kid growth and capretto quality and increase profits.

Maiden Cashmere does with a single fetus were supplemented with lupins for 1 week before kidding. Colostrum produced at the point of kidding and milk produced up to Week 10 of lactation by these does were measured. Kid survival, birth weight and growth rate up to 10 weeks of age were also measured. At 10 weeks of age, kids were slaughtered and the quality and quantity of capretto were measured. The profits were calculated from the feeding costs of does and possible return from the sale of kids at different weeks of age.

Does supplemented with lupins before kidding produced more colostrum than the does fed the basal diet only. However, the survival and birth weight of kids were not affected. The milk production of does remained similar irrespective of the supplement fed before kidding. The kids grew at the same rate and produced the similar quantity and quality of capretto irrespective of the supplement fed to their mothers. The optimal age and live weight of kids at sale for the maximum profit were found to be 8.3 weeks and 13.5 kg respectively.

The use of maiden Cashmere does seems successful for premium quality capretto production. Supplementing the maiden Cashmere does prior to kidding does not seem to enhance capretto production for the conditions of this experiment. Such supplement might be beneficial under field conditions and in the case of multiple births. This needs to be tested. Kids need to be sold at their optimal age or live weight for a profitable capretto enterprise.

**Keywords:** Capretto, colostrum, feeding, kid (goat), milk, profits



## Expanding Rural Poultry Production through the Use of Processed, Low Cost Cassava Fruit Coat as Alternative Fibre Source

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Cassava fruit coat is a rural by-product of cassava processing. It is free of hydrocyanic acid (HCN), the anti-nutritional factor and toxic component in cassava often found in the roots, branches and leaves of the plant. The coats were processed into meal and used to replace to wheat offal, an expensive fibre component in poultry rations. Cassava fruit coat meal (CFCM) was used to replace 25, 50, 75 and 100% of the wheat offal in a standard broiler diet. One hundred and twenty-five one-week old broiler chicks of the Anak strain were randomly allocated to the five experimental diets on weight basis with each treatment having five replicates of five birds each. The birds were fed the starter and finisher diets *ad libitum* for a total period of eighth weeks during which weekly body weights and feed intake were recorded. Access to clean and fresh water was unrestricted. At the end of the eight week the birds were sacrificed for carcass measures and the weights of the organs taken. At the starter and finisher phases, the feed consumption of the birds was not significantly affected by levels of CFCM upto 50%, the weights of the birds and feed conversion were significantly ( $p < 0.05$ ) affected. Replacing wheat offal with CFCM had no effect on the carcass measures except for the meat to bone ratio which was significantly reduced when the CFCM level was above 50%. The digestibilities of nutrients were unaffected. Replacing wheat offal with CFCM resulted in significant reduction in the cost of feed but above the 50% replacement, the cost of producing 1 kg of broiler was significantly increased apparently due to the reduced weights of the birds at this level of CFCM inclusion. Results of the study showed that replacing wheat offal (an expensive fibre source) with processed cassava fruit coat can encourage the integration of this cassava by-product into feed for rural poultry production.

**Keywords:** Cassava fruit coat, processing, rural poultry production

## Feeding Strategies for Dairy Cattle Nutrition in West African Cities

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In order to improve our understanding of the adequacy of milking cow nutrition in the periurban dairy systems of West African cities, live weight trends, milk yield and metabolic profiles of experimental animals were investigated using 27 lactating cows (nine N'Dama, nine HolsteinXN'Dama and nine JerseyXN'Dama).

For each genotype, cows were randomly allocated into medium and high dietary levels. Diets consisted of ad libitum groundnut hay (medium) and ad libitum hay supplemented with locally sourced concentrates (high). The objective was to determine the adequacy or otherwise of two test feed regimes through milk yield and the metabolic responses of the milking cows. All cows were offered ad libitum dietary intake on 120 % of voluntary feed intake. The cows were milked in accordance with traditional practices and milk yield was measured daily. Blood samples were taken for tests for energy and protein metabolites at weekly intervals.

The milk yield was 1, 3.2 and 4 ½<sub>l</sub> for medium and 1.4, 4.1 and 5 ½<sub>l</sub> for high diets offered N'Dama, NDxJ and NDxH-F respectively. There was significant ( $p < 0.05$ ) breed and diet effects on milk yield. The live weight trend was —74, -345 and —192 g/day (medium diet) and —11, -140 and —88 g/day (high diet) for N'Dama, NDxJ and NDxH-F. The difference in weight gain was significant between the two regimes and across the breeds.

The concentrations of all metabolites observed in the study were within normal ranges albeit with a significant breed effect. Diet did not affect concentration of energy metabolites within breed but for N'DamaXJersey cows, the high plane diet induced a higher degree of energy metabolism. Data from live weight suggest that the N'Dama lost the least weight through the study and that although statistically different, metabolic profile of other breeds did not suggest undue nutritional stresses as concentrations of the metabolites were within normal ranges. The study concludes on the adequacy of the high plane diet for the crossbred cows but raises concerns on the appropriateness of high plane diets for lactating N'Dama cows from an economic perspective.

**Keywords:** Crossbreed, Feeding strategy, Milk yield, N'Dama, West Africa

## Employment of Working Elephants in Myanmar — Myths and Tradition in Conflict with Reality

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The domestication of elephants and their employment in timber extraction has a long tradition in Myanmar. Also in other parts of the world, people have an idea about the life of working elephants and their oozies (mahouts or elephant rider). Many stories and myths about the great friendship between domesticated elephants and their oozies go round: Children that grow up with baby elephants and live together all their life, helping and caring for each other. There might exist some friendship like described, but they are rare exceptions.

- How does reality of working elephants looks like?
- How do elephant and humans work together?
- What is myth, what is true?
- How does globalisation and thus new ideas of consumption influence tradition?

True is, that working elephants are still employed in Burmese silviculture to drag timber and up to today, dragging gear, taming and training methods were hardly modified. Also today, people believe in ghosts and natural spirits, called “Nats”. In elephant camps the spirit of the elephant nat is still worshipped.

But during four month living in elephant camps, not a single elephants seemed to have any special affection for its oozies. Many oozies in contrast like their elephant. But on-sided affection can not be called “friendship”. Low salaries for elephant workers and basic standard of living provoke, that many oozies leave their elephants, to earn more money with other work. Besides, the invasion of new products and the awareness of a new life style transmitted through television, accelerate the changing processes in elephant camps.

Ideas to improve the management of working elephants and the situation of oozies and their families already exist in Myanmar. Modern taming and training methods avoiding physical punishment for the training elephants are in implementation as well as better living conditions for local people in rural areas, to keep the workers and their families in the camps. Myanmar hopes to keep its old tradition upright by integrating new ideas.

**Keywords:** Globalisation, Myanmar, regional identity, tradition, working elephants

## Free-range and Confined Production System of Layer Chicken in Cambodia

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Intensive livestock production has greatly increased the productivity and efficiency of food production but also resulted in considerable criticism by various segment of society. The ban of confined layers chicken in the cages is effective in European countries but this system is still implemented among farmers and producers in Tropics. Short term profiles of confined system are emphasised at the expense of animal welfare, soil fertility and sustainability. However, evidence of the comparison of confinement and free-range layers production in Cambodia is not yet investigated. The objective of this experiment is to evaluate the productivity of free-range (FS) and confined layer chicken production system (CS). 1400 twenty week-old ISA-Brown chicken were divided into two groups of production system, FS and CS. Chicken in FS were kept on an open area of concrete floor covered by rice husk and free-access to wooden nest for laying egg whereas those in CS were confined in individual cage. Feed, supplemented with fresh vegetable and water were provided ad-libitum during 12 weeks of experiment. At the last 4 weeks of the end of experiment, egg production among was stagnant, but slightly significant difference, 75.12 % of FS and 70.02 of CS. Daily feed intake and egg weight in grams of FS were higher than CS, 114.02 and 103.05, and 62.35 and 57.80 respectively. Due to cannibalism, mortality of layers in FS (9.57) were higher than CS (1.86). Moreover, the feed conversion ratio (grams feed/1 gram eggs) of FS (2.43) were better than CF (2.55) significantly. Eggs produced in FS were preferred among consumer on the market. However, management of this system required a high productive cost in preventing the prevalence of disease and cannibalism. While labour cost in tropical country is not a constraint in livestock production, free-range layer production system is an approach of animal welfare attention and long-term benefit.

**Keywords:** Confined system, free range system, layer chickens

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## Adaptation of *Brachiaria* species to Low-P Soils

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Brachiaria grasses are the most widely planted tropical forage grass. However, mechanisms of Brachiaria that contribute to successful adaptation to low-fertility acid soils are poorly understood. Since phosphorus availability in soil is the major limitation in many tropical ecosystems, the main focus is on understanding P acquisition and use in these grasses. Comparative studies between the two species, *B. decumbens* (with good acid soil adaptation) and *B. ruziziensis* (poorer adaptation), are conducted by following growth in soils as well as under hydroponic conditions. Adaptations for increased phosphate availability and Pi uptake efficiency include mechanisms to expand plant root surface area, enhanced expression of Pi transporters, increased organic acid synthesis and exudation, phosphatase secretion and mycorrhizal symbiosis. Interest in root growth in Brachiaria grasses stems from the observation that root traits appear to be important for genotypic differences in plant adaptation to low-P soils. Studies to compare shoot and root growth responses of both Brachiaria species in acidic Colombian soil treatments, showed that *B. decumbens* grows better than *B. ruziziensis* in low-P soil. This was mainly due to the ability of *B. decumbens* to develop a highly branched actively growing root system. It is possible that this grass could access less available P forms from low-P soil. 31P-NMR studies are undertaken to elucidate the organic-P component in the soils. Results from pot experiments to determine the specific contribution of P fertilisation (from mineral and organic P sources) as a factor for the successful establishment of *B. decumbens* on the low-P soil will be presented. Low-P adaptation of Brachiaria species has been attributed in part to mycorrhizal associations, therefore, such a contribution cannot be excluded since mycorrhizal infection was particularly evident in *B. decumbens* in the low-P soil. Plant responses towards conservation of P use include decreased growth rate, increased growth per unit of P uptake and remobilisation of internal Pi. P use efficiency in the Brachiaria species will be addressed in future studies, and, in particular, the distribution of plant P into metabolic pools and physical compartments to understand maintenance of Pi homeostasis.

**Keywords:** Brachiaria, forage grass, genotypes, phosphorus efficiency, Pi homeostasis, root traits, tropical soils

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## Promoting the Rational Use of Animal Health Drugs for the Prevention of Drug Resistance

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African farmer-families depend on livestock for food, growing crops for subsistence and sale, savings and meeting social obligations. With high levels of animal disease, farmers rely on animal health drugs to safeguard their livestock; drug resistance puts this strategy at risk and has implications for human health. We present some preliminary results of a research project working on resistance to trypanocides in West Africa. We found that trypanocides are the single most important veterinary drug and that most treatments are given by farmers. Epidemiological studies and Participatory Rural Appraisals demonstrated the importance of trypanosomiasis and the reliance of farmers on trypanocides to control this disease. We also confirmed the finding of previous studies, that drug resistance to trypanocides is widespread — a phenomenon linked to the overuse and misuse of drugs. As a contribution towards the project objective of safe-guarding the use of trypanocides, we assessed the strategy of training farmers in Rational Drug Use. Residential training was given and farmer field schools held in 6 villages in south-west Burkina Faso; the content and process of these are summarised. Evaluation at the end of training and at 1 year follow-up showed that farmers had significant improvements in knowledge and competencies after training. We also found beneficial effects on the health of their animals. We draw comparisons with studies on Rational Drug Use in human health; these have shown the benefits which can be obtained by Rational Drug Use interventions and have identified the criteria for success. We discuss the constraints to wider implementation of this type of initiative in animal health. These constraints are mainly due to a disabling policy environment, in which the interests and needs of farmers are marginalised. Recommendations are made for the resolution of these constraints.

**Keywords:** Animal health, drug resistance, policy environment, rational drug use, training

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## **The Forage Potential of Tanniniferous Legumes — Search for Sustainable Ways to Cope with Nutritional Limitations in Smallholder Livestock**

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Ruminants play an important role as assets and sources of high quality food and income for rural populations in the developing world. Ruminant productivity is usually low due to inadequate nutrition (i.e. protein deficiency). Promising forage species, mainly legumes, have been identified to overcome these limitations. Many of these legume species contain tannins that could be either advantageous or disadvantageous in terms of feed efficiency and metabolizable protein supply to the animal. The overall aim of this project is to develop efficient feeding systems based on tanniniferous shrub and tree legumes in order to improve livestock productivity and to alleviate poverty of smallholders in the tropics. This will be achieved through (i) studying the effect of plant nutritional status on the accumulation of condensed tannins in legumes, and the influence of these tannins in ruminant nutrition and the nitrogen fertiliser value of animal excreta for plants, and (ii) designing optimal feeding strategies based on the use of mixtures of tropical forage legumes with contrasting tannin contents to overcome the limitations of ruminant diets in protein supply. At the end of the project period, the potential impact of the obtained results will be assessed by an ex-ante economic analysis at farm level and at ecoregional levels. The outcomes of this work should provide the necessary background information for better feeding practices based on tanniniferous legumes. By dissemination and adaptation of the project outputs with farmers, the new management and feeding strategies will improve the nutrient supply for the ruminant animals, which will increase feed use efficiency and animal productivity in low-input livestock systems. This, in turn, will increase competitiveness and income of the farm households.

**Keywords:** Grass, legumes, livestock, protein, tannins

## Effect of Dry and Wet Season Feeding on Milk Production and Quality of Cows Kept at High Altitude in the Peruvian Andes

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Relatively little is known about the actual situation concerning milk yield and quality in the Peruvian highlands, particularly when regarding seasonal variation in milk composition. Therefore a survey was conducted to collect data and perform analyses on the status of feed resources as well as milk production and quality on four different farms at contrasting altitudes in the Peruvian Andes (3200 to 4250 m a.s.l.). On three of the experimental farms, cattle production was based on cultivated pastures and one farm relied on native grassland. Forage quality (described as crude protein and fibre content) of cultivated pastures was clearly higher ( $p < 0.01$ ) than that of native grassland and was higher ( $p < 0.01$ ) during the rainy season than during the dry season. On average, milk production per cow was 20 % lower ( $p < 0.05$ ) in the dry season as compared to the rainy season, but differences among individual farms were large. While the decrease in milk yield on the most intensively managed farm at 3200 m a.s.l. was only about 10 %, milk yield was 30 % lower on the most extensively managed farm at 4250 m a.s.l. during the dry season than during the rainy season. Also milk composition was clearly affected by season. Fat, protein and casein concentrations were lower ( $p < 0.01$ ) during the dry season than during the rainy season. Differences among farms were large and the decrease in these milk constituents was much more pronounced on the extensively managed farm at 4250 m a.s.l. than on the remaining farms. On this farm, fat concentration decreased by over 20 % and protein and casein concentration by 10 % during the dry season. Because both milk yield and milk quality were decreasing at the same time, the unfavourable effects of the lower feed quality in the dry season were amplified. When processing the milk to cheese or similar dairy products, the loss of income is multifold as (i) there is less milk, (ii) this milk yields far less cheese due to the lower fat and protein content, and (iii) cheese quality may be impaired due to the less favourable milk renneting properties associated with reduced protein (casein) content. Efficient dry-season feeding strategies are required to overcome this unfavorable situation.

**Keywords:** Altitude, dry season, cattle, milk composition

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# Subsession 3d: Technologies for Integration of Crop and Livestock Systems

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## **Technologies for Integration of Crop and Livestock Systems Aiming at Improved Livelihood Outcomes**

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Integration of crop and livestock systems in the tropics can be discussed at national, regional and household level. Examples of integration technology are the use of crop residues as animal feed, the use of animal manure to fertilise crops and the use of animal power to improve soil tillage and to cope with labour constraints.

Most crop residues are cereal straws of very low quality. Digestibility, crude protein content and intake need to be improved to make them useful as animal feed. Offering large quantities of these heterogeneous feeds allows for selection by the animals, treatment with urea and supplementation can upgrade the entire diet. Crop residues or legumes used as green manure can replace animal manure and allow for disentangling crop and animal production.. Characteristics determining use of plant material are C-N ratio, polyphenol content and lignin content of the residues. Including legumes or other specific crops in the cropping pattern for animal feed contribute to supporting the integration at farm household level.

Advantages of the integration of crop and livestock systems are optimisation of nutrient cycling, labour use and cash flow. It offers the opportunity to transform waste products into valuable products such as meat and milk. Households use technologies of integration to achieve livelihood outcomes such as food and nutritional security, increase in income and well-being, decrease in vulnerability and risk, and more sustainable use of natural resources. Although integration seems an option with many advantages the alternatives of diversification within one system and exchange between specialised systems may have additional benefits

**Keywords:** Crop systems, livestock systems

## Small Ruminants Role in the Integration of Crop Production and Livestock System in Central Java-indonesia

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Cattle are the main component in the crop-livestock production systems, while small ruminants role in this integration depend on the type of crop grown by the farmers. This paper presents the integration of crop and small ruminants production in different agro-ecozone in Indonesia. In total, 172 small ruminant farmers from the three agro-ecozones, lowlands, middle zone and uplands, in Central Java-Indonesia, were involved in the study. The study was conducted in one year, using both interview and direct investigation. The data consisted of land possession, crop production, the macronutrient of small ruminants manure and soil (carbon, nitrogen, phosphorus, potassium, nitrate and C:N ratio). The results indicated that farmers in the lowlands have a fewer lands compared to the farmers in the middle zone and uplands area. The composition of land in the lowlands dominated by paddy field, while in the middle zone and uplands were fields and farmyards, as a result, rice is the main crop grown by the farmers in the lowlands, while in the middle zone and uplands, it was annual crop. The macronutrient quality of soil and manure in the lowlands was also poorer than those in the middle zone and uplands. The chemical composition of soil (N, P, K) in the lowlands was 0.13 %; 627.2 mg/kg and 2121.1 mg/kg, in the middle zone and uplands was 0.55 %; 1295 mg/kg; 358.5 and 0.22 %; 910.1 mg/kg; 2698.9 mg/kg, respectively, while the composition of small ruminants manure in the lowlands was 0.87 %; 1712.3 mg/kg and 19098.2 mg/kg of N, P, K, respectively. In the middle zone and uplands, it was 1.71 %; 2279.1 mg/kg; 19462.1 mg/kg and 1.19 %; 1657.1 mg/kg; 19866.1 mg/kg, respectively. The study indicated that integration of crop and small ruminants production has been well applied in the higher zone. In the lowlands, grazing is the main integration between small ruminants and crop since the paddy field residues have not palatable as small ruminants feed.

**Keywords:** Central Java, crop, integration, small ruminants

## Feeding More People per Hectare with a Vegetarian Diet or a Diet with Milk?

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Some vegetarians (e.g. H. MAUCHER, chef of Nestlé until 1997) believe that consuming animal products including milk is an intolerable waste of global food supply. The objective of this study was to compare the efficiency of converting crop biomass into human food by using the biomass either as forage for milk production or as green manure for grain production as it is practised in stockless organic farms. Feed energy conversion efficiency for milk production was calculated with data from published experiments with Holstein dairy cows in Bavaria (including heifer production) and with standard metabolic efficiency values. The food grain production efficiency of green manure and animal manure was calculated in carbon (C) units using published field and laboratory experiments in temperate regions. The results were calculated for 100 kg biomass C: If 100 kg C are applied as green manure on a grain crop with a 50 % harvest index, grain yield increases by 9 kg C. Feeding 100 kg forage biomass C to dairy cows produces an amount of animal manure that is equivalent to 79 kg green manure C, because soil accumulation of animal manure is 2.5-times higher than of green manure. This amount of animal manure application improves grain yield by 7 kg C. In addition, the digested fodder C fraction (60 %) is converted to 20 kg milk C at 34 % efficiency. Thus the dairy system transforms biomass 3-times  $[(20+7)/9]$  more efficient into human food with a higher economic value than the vegetarian system with green manure application. Using tropical data in the same calculation, the dairy system with an energetic efficiency of 20 % transformed biomass 2-times more efficient into food than the vegetarian system. To conclude, a vegetarian diet may convert less crop biomass into human food than a diet that includes also milk if some crop biomass is required for green manure application to substitute for animal manure.

**Keywords:** Animal manure, carrying capacity, green manure

## **Integrating Pigs and Maize Production in a Low Input Production System in the Tropic of Mexico**

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In the tropic of Mexico the “Milpa” system is a very traditional farming system. However, the spatial separation of the crops and animals results in a one way flux of nutrients from crop fields to the home gardens. Additionally there is a tendency towards a reduction of the fallow period of the forest. Both factors causes a considerable reduction in the maize yield. The objective of the experiment was to determine whether the use of pigs in a field rotation has a beneficial effect on maize yield.

The treatments designed were as follows: traditionally slash and burn (TT), keeping pigs before the cultivation of maize (PiK) and a control without pigs and without burn (WOPB). Creole pigs were used and were feed with a 12 % protein diet consisting of 75 % maize and 25 % heated mucuna bean. The parameters measured were pig performance, amount of weeds, labour time, soil mineral nitrogen and maize yield. There were two repetitions of the TT and three for PPS and WOPB treatments.

Pig performance was similar in the three groups. A reduction of maize yield was found in TT and WOPB and no reduction was found in PPS compared to first year ( $p < 0.01$ ). Lower weeds were found in PiK compared to TT and WOPB ( $p < 0.01$ ). Labour time for weed control was reduced in PiK compared to TT and WOPB. Higher mineral nitrogen in the soil was found in PiK. A better input/output of nitrogen was observed in PiK compared to TT.

The use of pigs in a field rotation with maize is a method of low input and provide advantages in optimise the nitrogen balance in the production system. This can stabilise the maize production without the use of fire with benefits not only for the farmers but also to the global environment. Further research is needed to optimise the use of pigs for a sustainable production of maize.

**Keywords:** Low inputs, maize, pigs, rotation

## **The Effect of Replacing Fresh Water Spinach with Basal Diet on Performance of Fattening Pigs in Cambodia**

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Where water supply is adequate or there is supplementary irrigation, water plants can be highly productive sources of protein-rich biomass and are ideal complements for fibre-free basal diets in pig and poultry feeding systems. Fresh water plant is ideally rich in water content and vitamin and low anti-nutritional factors. In pig feeding system among farmers, water spinach, an important water plant, is a major source of fresh vegetable supplementary. The objective of this paper is to evaluate the effect of replacing graded level of fresh water spinach (*Ipomoeae aquatica* F.) with basal diet on performance of fattening pigs in Cambodia. 36 castrated pigs with 32.90 kg in initial body weight were assigned into a completely randomised design with 4 treatments and 3 replications. During 12 weeks of experiment pigs in group A, the control group, receive a balanced diet of 14 % protein and 11.57 metabolisable energy whereas those in B, C and D received 10 %, 20 % and 30 % of fresh water spinach replaced with the basal diet. At the end of the experiment, body weight of pigs in group B was 85.03 kg following by A (81.43 kg), C (77.50 kg) and D (70.50 kg) ( $p < 0.05$ ). Daily dry matter intake of pigs in group B were 2.02 kg higher than A (2.02 kg), C (1.96 kg) and D (1.61 kg) significantly. The average feed conversion ratios of the experimental groups were 3.5, 3.8, 3.7 and 3.6 of A, B, C and D respectively without significant difference. Occurrences of greenish and mud manure were found in pigs of the last group which 30 % of vegetable was used to replace basal feed. Replacing of fresh water spinach can optimally replace the basal diet not more than 20 % which in return bringing a high benefit. However, attention must be paid to avoid the contamination of water-born disease contaminated to animal via undesirable flora found in the plant.

**Keywords:** Fattening pig, integrated farming system, water spinach



## Nitrogen Balance of Ensiled Cassava Leaves in Piglets in Cambodia

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Cassava is an important energy-providing crop in Cambodia which is mostly planted along the fertile Mekong river basin. The leaves are rich in nutrients but also in HCN, a toxic glycosidic compound. Its content can be reduced to non-lethal dose by ensiled. The experiment was conducted in the animal research station of the Royal University of Agriculture in Cambodia to determine the nitrogen (N) balance of piglets fed ensiled cassava leaves (ECL). Eight castrated male piglets of Mongcai breed kept in metabolic cages were divided into two groups, A and B. Animals in group A were fed ECL mixed with fish meal and sugar palm syrup whereas this mixture was supplemented with 1 % of Methionine, in the diet of group B. The feed ingredients of research diet are available local feed resource except the imported Methionine. Five days of data collection of feed residue, faeces and urine was implemented after 5 days of adaptation period. Even though there was a higher trend in group B, no significant difference in nitrogen (N) digestion (65.06 % of A and 72.45 % of B) and daily individual N retention (9.78g of A and 12.24g of B) was found. However, group A had a lower N retention as % of N intake than B, 36.65 % and 44.92 respectively ( $p < 0.05$ ). There were investigated no significant difference between both groups in N retention as % of N digested (57.58 and 62.11) and organic matter digestion (51.32 and 54.72 respectively). According to this preliminary study, ensiled cassava leaves can be utilised as protein source in piglet diet without any negative effects. ECL originating from Mekong river basin required no supplementation of Methionine. Further animal feeding trial with optimum sample size should be conducted to confirm the result.

**Keywords:** Digestibility, ensiled cassava leaves, Methionine, piglets

## Possibilities for the Natural Adjustment of the Millipedes Exemplary of *Spinotarsus caboverdus* PIERRARD on Cape Verde

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The eating activity of the millipedes *S. caboverdus* on Cape Verde has been observed all year round and leads to serious damage of many cultivated plants important for the nutrition of the inhabitants (e.g. corn, shrub beans, potato, sweet potato, cassava, papaya, mango, bread fruit, cabbage, pumpkin). Briefly, when rain is forecasted the Diplopoda crop up in huge crowds. They appear on their nocturnal migration locally and even populate residential areas.

Substantial chemical measures (e.g. seals with Uden 75 WP) which were tested years ago gained only a short term success but hardly influenced the weak ecological equilibrium of Santo Antao. Therefore non-chemical protection measures including natural opponents have to be developed and established to combat the pest.

First of all biological and behavioural studies have to be carried out to get basic information on the life cycle of the millipedes. Field evaluations and inquiries regarding the population's division in different locations, the animal's pattern of life and daily rhythm on-site were carried out in combination with laboratory surveys on reproduction and egg deposition. Deductive procedures are worked out for sustainable support of the natural limitations of the pest's life expectancy. These procedures also include the cultivation technology for example the soil structure and use of resistant potato varieties.

The spectrum of natural opponents in the field has proved to be very small. Predators disdain the millipedes and hardly be considered as active biological control agents.

Micro-organisms for example *Acremonium* sp., *Aspergillus* sp. and *Paecilomyces* sp. were isolated in a limited circumference from adults and eggs of *S. caboverdus* in irrigation areas. Under laboratory conditions the application of selected entomopathogenic fungi as there are *Beauveria bassiana*, *Paecilomyces fumosoroseus* and *Metarrhizium anisopliae* showed fundamental pathogenic effects on adults and older juveniles of *S. caboverdus*. An application strategy using these fungi is suggested to obtain a lasting adjustment of the millipedes.

**Keywords:** Entomopathogenic fungi, millipedes, natural adjustment, *Spinotarsus caboverdus*

## **Influence of Plant Species and Conservation Method on Voluntary Intake and Digestibility of Dry Matter and Organic Matter of *Brachiaria ruziziensis* and *Streblus asper* LOUR in Goat under the Humid Tropical Climate**

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This study was conducted to evaluate the influence of plant species and conservation method on voluntary intake of dry matter and organic matter in goats. Four male goats weighing 33.75 ± 7–4.11 kg were used. Two Plant species, Ruzi grass (*BRACHIARIA RUZIZIENSIS*) and Streblus leaves (*Streblus asper* LOUR) sundried or ensiled with 5% cane molasses were used as the four feeds. The animals received the 4 different feed types in sequence in 4 periods in a 4 × 4 Latin square design. Each period lasted for 14 days with 9 days adaptation and 5 days for data collection. The animals were fed ad libitum. The feed offered and refused was recorded daily. Feed samples and the animal's dung were collected daily during the collection period and analysed for dry matter and organic matter content. The voluntary intake of the ensiled streblus leaves expressed either on dry matter ( $p < 0.01$ ), percentage body weight ( $p < 0.01$ ) and metabolic body weight ( $p < 0.01$ ) basis was highest. The goats fed on ensiled Ruzi grass had the lowest voluntary feed intake ( $p < 0.01$ ) on all parameters assessed. The trend in organic matter intake was similar to that of dry matter intake. Ensiled streblus leaves had the highest organic matter intake ( $p < 0.01$ ) whereas ensiled Ruzi grass had the lowest ( $p < 0.01$ ). The digestibility of both dry matter and organic matter were not significantly different across treatments ( $p > 0.05$ ). However, the D-value of feed was significant different across treatments ( $p < 0.01$ ). Dry Ruzi grass had the highest D-value ( $p < 0.01$ ). This research implies that the proper method for conservation of feed resources used for ruminant animal feeding is crucial.

**Keywords:** Conservation method, dry matter digestibility, organic matter digestibility, Ruzi grass, Streblus leaf, voluntary intake

## **Performance of Broiler Chickens and Fattening Pigs Fed Cassava Leave Meal Irrigated with Biodigester Effluent**

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The enormous biodiversity of the tropics provide the incredible opportunities for sustainable development, in which its long term running are supported within the scope of rational exploitation even though the attempts of consideration is not by far a priority. It is reasonable in combining the utilisation of cassava leave meal (CLM) and livestock production on fertile Mekong River basin. Chicken and pig raising of the bank of the river were found commonly where few variety of cassava were grow seasonally. Because the household income source of farmers within this are is not totally based on unique source, additional attempts to use cassava leaf meal as a substitute for other protein supplements in animal diets have been less encouraged. The paper aimed to evaluate the effect of CLM on performance of broiler chicken and fattening pig. Completed randomised experiments were designed to chicken and pig trial with 8 weeks period. 320 day-old chicks and 16 castrated pigs 40.2 kg in initial weight were allocated into 4 treatments each with 4 replications. Sun-dried CLM harvested from biodigester-irrigated land which provided a high biomass to plants and believed to reduce anti-nutritional substance in CLM, were included 0, 10, 20 and 30 % in group A, B, C and D of the basal diet. Increased levels of CLM significantly reduced daily feed intake (g) 100.6, 96.2, 90.5 and 80.3 (SEM 0.98) in chicken and 2618.9, 2560.8, 2564.9 and 2274.7 (SEM 58.82) in pig and therefore reduced body weight (kg) 2.52, 1.94, 1.79 and 1.68 (SEM 16,06) in chicken and 77.50, 71.50, 65.96 and 60.22 (SEM 1.37) in pig. Feed conversion ratio were 2.26, 2.82, 2.88 and 2.73 (SEM 0.05) of chicken and 3.93, 4.58, 5.58, 6.36 (SEM 0.05) of pig in groups A, B, C and D respectively. Mortality of chickens fed graded level of CLM was increased. CLM should not be included into monogastric animal diet more than 20 % where the optimum economic return is reached unless any supplementations were added. Integrated cassava plantation with biodigester effluent is a solution of increasing biomass yield of plant and animal.

**Keywords:** Animal feed, cassava leave meal, intergrated crop-animal system

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## **Effect of Fumaric Acid Supplementation on Rumen Fermentation in Dairy Cows**

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The experiment was conducted to determine the effect of fumaric acid supplementation on pattern of rumen fermentation in dairy cows. Four crossbred Thai Native × Holstein Friesian cows with average body weight of  $416 \pm 54$  kg fitted with rumen fistula were used in the experiment. The animals were divided into 2 groups of two animals each and used in a  $2 \times 2$  crossover design. The cows were fed twice daily at 0600 and 1800 hours with 2 kg each of rice straw and concentrate. Fumaric acid was supplemented at 2 % level of feed intake (80 g) in the treatment group. Rumen liquor was taken at 0900 hours for 4 days and analysed for volatile fatty acids. Rumen pH was measured directly in the ventral sac of the rumen with a gel electrode at —1, 1, 2, 3, 4, 5 and 6 hours after morning feeding. Ammonia nitrogen concentration was analysed from the rumen liquor taken at —1, 1, 2, 3 and 5 hours after feeding. The concentrations of propionic acid, butyric acid and total volatile fatty acids of cows fed with fumaric acid were significantly higher than in cows not supplemented with fumaric acid ( $p < 0.05$ ). The concentration of acetic acid in both treatments was not significantly different ( $p > 0.05$ ). The cows fed with fumaric acid had less ammonia nitrogen in the rumen at —1 and 1 hour after feeding than the cows not supplemented with fumaric acid ( $p < 0.01$ ). The rumen pH at —1, 1, 2, 3, 4, 5, and 6 hours after feeding in both treatments were not significantly different ( $p > 0.05$ ).

**Keywords:** Ammonia-nitrogen, dairy cow, fumaric acid, rumen pH, volatile fatty acid

## Reduction of N-excretion in Growing-finishing Pigs Using Low Protein Diets

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The influence of protein level in pig diets on nitrogen excretion was evaluated using three crossbred barrows (DxLWxLR) in a  $3 \times 3$  latin square design study. The pigs were fed with one of grower pig (50 kg BW) diets containing 18, 16 and 14 % crude protein (CP), respectively, with the same 0.77 % apparent ileal digestible lysine. The finisher pig (65 kg BW) diets contained 15.5, 13.5 and 11.5 % CP, respectively, with the same 0.61 % digestible lysine. The diets were referred to as diets 1, 2 and 3, respectively. Average feed intake (FI,  $\text{g d}^{-1}$ ) of grower pigs fed diet 3 tended to be lower than others. As a result, the pigs fed diet 3 had significantly lower ( $p < 0.05$ ) average N intake (Ni;  $\text{g d}^{-1}$ ) than the pigs fed diet 1. Urinary N (Nu;  $\text{g d}^{-1}$ ) and faecal N (Nf;  $\text{g d}^{-1}$ ) excretion was significantly lower ( $p < 0.05$ ) for the pigs fed diets 2 and 3 than the pigs fed diet 1. There were no significant ( $p > 0.05$ ) differences in Nu:Nf ratio among treatments. The pigs fed diet 3 had lowest ( $p < 0.05$ ) N excretion in slurry (Ne,  $\text{g d}^{-1}$  and % Ni) and had highest ( $p < 0.05$ ) N retention. There were no significant ( $p > 0.05$ ) differences in FI among treatments in finishing phase. However, Ni of pigs fed diet 3 tended ( $p > 0.05$ ) to be lower than the others and tended ( $p > 0.05$ ) to have lowest Nu. On the other hand, the pigs fed diet 1 had the highest ( $p < 0.05$ ) Nf and tended ( $p > 0.05$ ) to have the highest Ne. Results of the present study showed that the reduction of CP from 18 to 14 % in grower pig diet could reduce N in urine, faeces and slurry by 84.72, 42.65 and 56.42 %, respectively while the reduction of CP from 15.5 to 11.5 % in finisher pig diets reduced N in urine, faeces and slurry by 59.80, 27.98 and 32.25 %, respectively. Dietary CP can therefore be reduced to 14 and 11.5 % in the growing and finishing phases of pig diets, respectively.

**Keywords:** Finishing pigs, growing pigs, low protein diet, N-excretion

## Use of Citric Acid and Clove Oil as Supplement in Weanling Pig Diets

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This experiment was conducted at Chiang Mai University, Thailand to determine the effect of supplementing citric acid (CA) and clove oil (CO) as feed additives in weanling pig diets. Thirty-six, 21-day old weanling pigs weighing  $7 \pm 0.5$  kg were randomly divided into four groups of nine animals each and used in a completely randomised design. Each group was allocated to one of four dietary treatments: 1. Control basal diet containing corn-soybean meal; 2. Basal diet supplemented CA at 2 g  $\text{kg}^{-1}$  diet; 3. Basal diet supplemented with CO at 2.5 ml  $\text{kg}^{-1}$ ; 4. Basal diet supplemented with CA+CO at 2 g + 2.5 ml  $\text{kg}^{-1}$ ; respectively. Diets were formulated to meet NRC (1998) standards. Each weanling pig was housed in an individual pen for the experimental duration. The growth performance and faecal characteristics were measured for 35 days. Average daily feed intake (ADFI), average daily gain (ADG) and feed conversion ratio (FCR) of the pigs were: 690, 668, 618, 635 and 344, 385, 341, 347  $\text{g d}^{-1}$  and 2.05, 1.74, 1.83 and 1.89 on diets 1 to 4, respectively. There were no significant ( $p > 0.05$ ) differences in ADFI and ADG among treatments. The pigs on the diet supplemented with CA, CO and CA+CO tended to have better FCR than the control group. Pigs on the diet supplemented with CA had a significantly ( $p < 0.05$ ) lower FCR than the control group. The faecal score for colour on the pigs fed diet 4 was significantly ( $p < 0.05$ ) better than the control group and also the pigs in this group had the lowest diarrhoea incidence. The results suggest that CA can be included at 2 g  $\text{kg}^{-1}$  in weanling pig diets.

**Keywords:** Citric acid, clove oil, weanling pig

## Effect of Phytase Supplement on Productive Performance of Growing-Finishing Pigs Fed Normal and Low Phosphorus Diets

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An experiment was conducted at Rajamangala Institute of Technology, Phitsanulok Campus, Thailand to determine the effect feeding diets containing normal and low phosphorus (P) contents supplemented with phytase on productive performance of growing-finishing pigs. A total of 16 castrates and 16 female cross-bred (DxLWxLR) pigs were divided into 4 groups under a Randomised Complete Block Design. Within each group, the pigs had an initial average body weight of 30 kg and were kept in individual steel metabolism cages equipped with a nipple waterer, a stainless steel feeder and urine and faeces collectors. Each group was allocated to one of the dietary treatments: Diet 1 (control, normal P level without phytase), Diet 2 (normal P level with phytase 1,000 U kg<sup>-1</sup>), Diet 3 (low P level without phytase) and Diet 4 (low P level with phytase 1,000 U kg<sup>-1</sup>). Averaged daily gain (ADG) and feed conversion ratio (FCR) were monitored under controlled conditions. At the end of the experiment, two males and two females from each group were slaughtered for carcass evaluation.

The ADG and FCR of pigs fed diets 1 to 4 were: 610, 700, 570 and 600 g d<sup>-1</sup> and 2.80, 2.60, 2.89 and 2.68, respectively. Significant differences ( $p < 0.05$ ) in ADG and FCR were observed. Also, dressing % and % lean differed significantly ( $p < 0.05$ ) averaging 78.41, 78.84, 76.23 and 78.27, and 43.63, 45.00, 40.96 and 42.85 %, respectively for the groups 1, 2, 3, & 4. Pigs fed diet 2 (normal P level with phytase 1,000 U kg<sup>-1</sup>) had significantly the best productive performance, while pigs fed diet 4 (low P level with phytase 1,000 U kg<sup>-1</sup>) did not differ from the controls (fed normal P level without phytase). It was concluded that the application of phytase as a feed additive improves productive performance of growing-finishing pigs.

**Keywords:** Growing-finishing pigs, carcass quality, phosphorus, phytase, productive performance



## The Effects of Feeding Diets with Normal and Low Phosphorus Contents Supplemented with Phytase on Phosphorus Excretion in Growing Pigs

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An experiment was conducted at Rajamangala Institute of Technology, Phitsanulok Campus, Thailand to investigate the effect feeding diets with normal and low phosphorus (P) contents supplemented with phytase on P excretion in growing pigs. Twenty cross-bred (DxLWxLR) castrated pigs were randomly divided into four groups under a Randomised Complete Block Design. Within each class the pigs had an initial average body weight (BW) of 30 kg and were kept in individual steel metabolism cages equipped with a nipple waterer, a stainless steel feeder and urine and faeces collectors. Each group was allocated to one of the dietary treatments: Diet 1 (control, normal P level without phytase), Diet 2 (normal P level with phytase 1,000 U kg<sup>-1</sup>), Diet 3 (low P level without phytase) and Diet 4 (low P level with phytase 1,000 U kg<sup>-1</sup>). The utilisation of P was determined.

The mean faecal P and P excretion in slurry (g/day) were 3.75, 3.16, 4.45 and 3.20 and 4.69, 4.00, 5.20 and 4.01, respectively. Faecal P and P excretion in slurry as percent of P intake were 32.02, 25.12, 41.55 and 30.85 and 40.04, 31.80, 48.55 and 38.66 %, respectively and differed significantly ( $p < 0.05$ ). P retention was 7.02, 8.58, 5.51 and 6.36 g/day and 59.96, 68.20, 51.45 and 61.34 %, respectively. Apparent P digestibility were 67.98, 74.88, 58.45 and 69.15 %, respectively and differed significantly ( $p < 0.05$ ). Pigs fed on diet 2 (normal P level with phytase 1,000 U kg<sup>-1</sup>) had the most P utilisation. Pigs fed diet 4 (low P level with phytase 1,000 U kg<sup>-1</sup>) showed no significant difference in P utilisation when compared with the control group (fed normal P level without phytase). The results indicate that supplemental phytase is effective in improving P utilisation in pigs and decreases P excretion in growing pigs.

**Keywords:** Growing pigs, apparent digestibility, excretion, phosphorus utilisation, phytase, retention

## Evaluation of an Outdoor Pig Fattening in Tropical Conditions

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In Yucatán, the most easterly territory of México, both poultry and pig production are carried out resembling an industrial model. Their main problems are the import-dependency of feedstuffs from the USA and their polluting effect.

In order to assess an outdoor pig production system (OutPPS) as an option to conventional system (ConPPS), an in-farm comparative trial was carried out. In a medium-sized farm, 52 pigs (males and females, cross-bred, 95 day-old,  $39.8 \pm 7.5$  kg) were assigned to both systems for a 60-day measuring period. ConPPS pigs (n=28) were managed as usual. OutPPS pigs (n=24) were raised on a yard (0.27 ha) of grass (*Cynodon nlemfuensis*) and weeds. Both groups were fed ad libitum with the same feed. The objectives were to compare animal performance (feed intake, live-weight gain, feed conversion rate, back-fat accretion, and parasitic infestation) and the use of water and labour; as well as to assess the pig effect on pasture cover and soil fertility.

ConPPS yielded a greater live-weight gain (6.1 kg;  $p < 0.01$ ), and a thicker back-fat layer (1.15 mm;  $p < 0.05$ ) than OutPPS. Neither differences were found in intake nor in feed conversion rate ( $p > 0.05$ ). Both groups were infested by parasites of *Isospora* and *Trichuris* genus. *Oesophagostomum* parasites were detected in ConPPS.

332.3 L water/10 pigs/day in OutSSP were saved with respect to ConPPS, whereas 11.67 more minutes of labour/10 pigs/day were required in the latter than in OutPPS ( $p < 0.001$ ).

The plant dry-matter removal reached 62.9 %, which represents 0.95 kg DM/pig-day. Pasture cover was reduced only by 2 %. No changes in C and N in soil contents occurred ( $p > 0.05$ ); however the potentially mineralisable N in soil organic matter increased by four fold at the end of the period.

Thus, saving water and labour; removing the polluting effect; and improving both carcass quality and soil capacity, have all a cost in terms of animal efficiency. Better management of the yard could possibly improve these results. However, in Yucatán where the soil is karstic and the underground water tables are too shallow, the industrialised livestock system do not seem to have good perspectives.

**Keywords:** On-farm research, outdoor system, pig, saving water, Yucatan

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## **An Improved Framework for the Economic Analysis of Animal Disease Control using the Damage Abatement Function**

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Every student of animal health economics is familiar with the theoretical framework for analysing animal disease control developed at Exeter (UK) and summarised by McInerney (1996). In this framework, disease is viewed as a “negative input” generating losses within a livestock production function. The livestock keeper responds by investing in “positive inputs” of disease control, whether in terms of veterinary products and service or management practices. The trade-off between disease and its control can then be represented as a “loss-expenditure frontier” with the optimal level of disease control lying at the point on the frontier where the marginal value of losses equals the marginal cost of control.

Considering disease control as a typical positive input in the production function, whether for a single health problem or for general health care, is certainly intuitively appealing. More spent on veterinary care is expected to translate into higher productivity and income at the animal or herd level. This view is widely accepted and is nearly universally reflected in specifications of livestock production functions which take some variant of the form  $Q = f(Z, X)$ , where  $Q$  is some measure of output,  $Z$  is other inputs (feed, etc.), and  $X$  represents veterinary inputs. See, for example, a recent article incorporating livestock production into the agricultural household model (Chilonda and Van Huylenbroeck, 1999). A similar approach was long applied to modelling the use of pesticides on crops, but recent research has found this approach to be inappropriate. In response, an improved damage control framework has been developed in the pesticide literature. This paper draws from this literature to propose an improved framework for analysing livestock disease control in developing countries.

**Keywords:** Animal disease, damage abatement function, livestock, production function

## **Bridging the Gap Between Integrated and Organic Agriculture to Ensure Food Security in the Tropics**

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Many tropical farming systems are evolving by expanding the cropped area and encroaching on the environment. Most of them are of organic nature and labour unproductive. The developing world is importing countless quantities of cereals, meat and other food, mostly from non-organic farming systems outside the tropics. In fact, the digestive tracts are largely colonised. There are cases where non-subsidised imports can be cheaper than locally produced commodities. Reversing this trend will imply farmer training and a healthy synergism between intensive and organic cultivation techniques.

Zero-tillage, enabled by herbicides like glyphosate has gained recognition as a second green revolution step. Seed coating, encompassing whatever fungicides and micro-fertilisers, in combination with appropriate seedbed preparation is another such step forward. In horticulture, drip irrigation and plastic tunnels are part of the hinterland of most tropical cities. Prophylactic treatment of crops and animals should be based on integrated health stimulating and target specific principles. In animal husbandry, both feed spectrum and genetic base should be appropriate. Most, intensively produced meat is based on cereal and oilseed feed. However, as prolonged feedlots are ecologically questionable, an increased market share of competitive grass-fed animals from improved, energy saving (sub)tropical pastures should be favoured. To enhance efficient use of inputs; **(i)** the integrated conservation approach of FAO for crop health, plant nutrition, water use and soil management should be encouraged, **(ii)** the target environment receptive, **(iii)** multiple use of inputs promoted, and **(iv)** unwanted residual elements remain below organic threshold levels. In either system, inputs should remain within environmentally acceptable standards. Not all natural substances are beneficial to insects, livestock and humans. Emphasis is put upon “vitalising” selected abiotic inputs into ecologically acceptable inputs and/or substrates.

**Keywords:** Food security, integrated agriculture, organic farming

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## Application of Animal Manure and Chemical Fertiliser in Lettuce Plantation on Degraded Soil in Cambodia

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Soil fertility degradation among vegetable plantation area in Cambodia is now profound due mainly to the misuse of chemical fertiliser. Lettuce, an important vegetable are planted on the Mekong River basin fertile soil, however the chemical fertiliser is still applied. The animal manure, units of integrated farming system in this area, is by far not properly applied. The objective of this paper is to evaluate the interaction of animal manure and chemical fertiliser on the yield of lettuce. 3\*3 factorial experiment with 3 replications were conducted with 3 kinds and 3 levels of fertilisers. Cattle dung (CD) and chicken manure (CM) were applied 0, 8 and 10 ton/ha whereas urea, the chemical fertiliser (CF) were applied at the level of 30, 60 and 90 kg N/ha while P and K were 30 kg/ha constantly. Single effect of CD improved yield of lettuce significantly, 17.13, 19.33 and 23.79 ton/ha in responded to 0, 8 and 10 ton/ha of CD respectively. Highly significant difference off yield of lettuce, 1.31, 21.32 and 25.62 ton/ha were found as affected by increased level of CM. There were no significant difference among groups applied CF, 19.79, 19.88 and 20.57 ton/ha of 30, 60 and 90 kg N/ha respectively. Dry matter content of lettuce were non-significant difference (7.32 %). Single effect of CD increased leave numbers of lettuce significantly, 16.46, 17.88 and 19.22 leaves/bush in responded to 0, 8 and 10 ton/ha of CD respectively. Highly significant difference of leave number of lettuce, 14.43, 18.73 and 20.40 leaves/bush were found as affected by increased level of CM. There were no significant difference among groups applied CF, 17.53, 17.84, 18.18 leaves/bush of 30, 60 and 90 kg N/ha respectively. Interaction effect between CD, CM and CF on yield, dry matter and leave numbers were not found. The use of chemical fertiliser on the Mekong River basin, therefore, is not recommended. Integrated farming system of livestock and vegetable is an approach of utilising efficiently the available resource and diminish the environmental pollution caused by animal manure and chemical fertilisers.

**Keywords:** Animal manure, chemical fertiliser, lettuce

## **Cattle Impact on Secondary Vegetation Proposed as Component for Smallholder Pastures in the Eastern Amazon, Brazil — Vegetation Development and Composition after 42 Months of Grazing**

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In the Eastern Amazon cattle pastures tend to ecologically degrade 7–10 years after establishment. Therefore, there is a need to develop sustainable cattle production systems. An innovative model for smallholdings was proposed integrating pastures as an intermediate stage between the crop and fallow phase in the slash-and-burn cultivation, which is still commonly practised in northeastern Pará. Preliminary results from a researcher-managed on-farm experiment showed that the partly tolerated secondary vegetation (capoeira) develops with only minor disturbances in the beginning of the pasture phase. Therefore, it was hypothesised that cattle will also not endanger further vegetation development. The vegetation of a grass-capoeira pasture (GCP) was compared against two controls in the form of a conventional grass (*Brachiaria humidicola*) pasture (GP) and an undisturbed re-growth of capoeira (UC). The pastures had been grazed in a rotational system at 1.49 and 1.23 LU ha<sup>-1</sup> in the first two phases and 0.91 LU ha<sup>-1</sup> in the third phase. Vegetation sampling was carried out in 10 m<sup>2</sup> subplots (n=30) 42 months after start of the first grazing phase (March 2000). In contrast to sampling after 16 months GCP had the highest phytodiversity although it decreased from 67 to 64 species. But UC showed a drastic decline from 72 to species 59 and thus was not different from GP ( $p < 0.05$ ), which remained at 57. The total soil cover, excluding the forage grass, declined on UC from 585 to 410 %, on GCP from 278 to 231 %, and stayed nearly constant on GP from 141 compared to 133 %. The strong decline in species number on UC was due to fewer herbs and grasses as the woody capoeira species had already started to shade them out. Concluding the cattle impact on a GCP remains uncritical for the restoration function in the fallow phase even after more than three years of grazing. The animal effect did not alter the capoeira. The biomass accumulation of the subsequent fallow will just be slightly retarded. The results confirm that GCP might be an interesting alternative to avoid ecological pasture degradation. However, further testing has to demonstrate the socio-economic feasibility of this type of pasture.

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**Keywords:** Animal production, capoeira, fallow vegetation, humid tropical pastures, phytodiversity, slash-and-burn system

## **Animal Source Foods and Nutrition During Early Life — An Evaluation of the Possible Link Between Livestock Keeping and Nutritional Status of Young Children in Resource Poor Areas**

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This interdisciplinary study has two major components; human nutrition and agricultural economics. The overall objective of this study is to evaluate the importance of animal source foods (ASF: milk products, eggs, meat, liver) as sources of energy, high quality protein and bioavailable micronutrients in young children consuming complementary foods in resource poor areas. The possible link between livestock keeping and nutrition during early life will be evaluated by including children from urban/periurban/rural households, stratified by livestock keeping (none, small livestock, dairy cows). Apparently healthy young children will be recruited into the study at 6 months of age, i.e., at the age when complementary foods should be introduced into the diet according to WHO recommendations. Detailed information about dietary intake and, in particular, on the introduction and consumption of ASF:s will be collected every two months during one year. In parallel, nutritional status, evaluated as growth (linear and ponderal) and morbidity (incidence and duration) will be monitored. Information about agro-economic factors (livestock keeping, income sources, own consumption of ASF versus market sales, expenditures etc.) will also be collected for each family every two months. A blood sample will be drawn at the end of the study to evaluate micronutrient status. The study will be implemented in Ethiopia.

The longitudinal study design and large sample size (about 600 children) of this study will provide an excellent opportunity to generate solid information on the importance of ASF:s and the impact of livestock keeping<sup>%%</sup> and the pathways by which it operates<sup>%%</sup> on nutritional status in young children in resource-poor areas. If, as expected, the key role of ASF:s in child nutrition is confirmed, the study results will provide the basis for subsequent intervention studies to determine the appropriate types, amounts, and frequencies of ASF:s to recommend as part of nutritional extension messages in Ethiopia. By describing the links between livestock keeping and child nutrition outcomes, the results will also aid in identifying potential livestock-based interventions to support improved child nutrition.

**Keywords:** Agricultural economics, animal source foods, Ethiopia, human nutrition, infants and young children, livestock keeping, micronutrients, periurban, urban

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## Saponin-containing Methanol Extract of *Sapindus rarak* Improved Sheep Performance Without Affecting Digestibility

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An *in vivo* feeding trial was conducted to investigate the effect of saponins-containing methanol extract to sheep performance. The experiment used 28 sheep, all fed with a mixture of dried sugar cane top and wheat pollard (75:25) at the level of 4 % body weight. Methanol extract of *S. rarak* (MS) was mixed with wheat pollard and was offered twice a day at the level 0, 4, 8 and 12 g/day to groups of 7 sheep each for 105 days. Faeces and urine collections were carried out twice at 4 weeks and 10 weeks of feeding for digestibility measurement. Urine was analysed for allantoin, uric acid and xanthine, hypoxanthine. Body weight was measured every two weeks. There was no negative effect of MS to intake as the intake over treatments was similar (average 61.7 g/W<sup>0.75</sup>). There was also no significant difference on OM, NDF or nitrogen digestibilities. However, there was an increase in average daily gain ( $p < 0.05$ ); those were 37, 35, 50 and 53 g/day for the level of 0, 4, 8 and 12g MS/day

, respectively. The increase of body weight gain was not due to intake or digestibility. There was no increase in nitrogen retention but the efficiency microbial protein synthesis (EMPS) was slightly increased; i.e 4.19, 5.55, 6.02 and 6.81 for the level of 0, 4, 8 and 12 g MS/ day ( $p > 0,05$ ). Other factors in MS or other effect of saponins in MS to the animal body that could contribute to the improvement of body weight cannot be overlooked . In conclusion, saponins-containing methanol extract of *Sapindus rarak* improved average daily gain.

**Keywords:** Body weight, digestibility, *Sapindus rarak*, saponin, sheep

## Agronomic and Farmers' Assessments of Multipurpose Forage Crops in Central Honduras

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Multipurpose forage crops can play an important role in improving the environmental and socio-economic sustainability of smallholder production systems in fragile environments. In the framework of a research implemented by CIAT and embedded in the BMZ/GTZ supported project "Participatory selection and strategic use of multipurpose forage germplasm in Central American hillsides", around 150 poor farmers in 15 communities in the department of Yoro, central Honduras, conducted more than 200 experiments in their own fields with several grasses, leguminous crops and shrubs. A systemic approach was employed, in which the choice of methods and parameters was determined simultaneously by both farmers and researchers. The trials took place in three different agro-ecological zones related to altitude in 2002 and 2003.

Grasses (*Brachiaria brizantha* 26610 "Toledo", *Andropogon gayanus*, *Pennisetum* spp. "Camerún" and "King Grass") performed well in more than 80 % of the experiments, without being significantly affected by altitude or rainfall.

Performance of legumes (*Lablab purpureus*, *Vigna unguiculata*, *Canavalia ensiformis* and *brasiliensis*) varied. Farmers assessed the results of 55 % of the trials as good or acceptable. Food security - being the primary concern - turned out to be the main criterion for the assessment of the new technologies. For instance, in the case of *Vigna* positive opinions were based on yield, use as food, feed, to enhance soil fertility and its drought resistance (all  $p < 0.05$ ). A significant negative aspect was susceptibility to pests. Leguminous shrubs — mainly represented by *Cratylia argentea* - showed in 75 % of the cases disappointing results. Since the plant is very much liked for its characteristics (high quality fodder, leaves covering the soil improving soil fertility and maintaining soil humidity, firewood), farmers continue experimenting with *Cratylia* in collaboration with researchers.

In combination with the provision of adequate information and a systematic follow-up, farmers were able to assess (new) forage based technologies properly when given the possibility to experiment freely. Valuable feedback has been provided to on-station research whereas at the same time many farmers have been motivated to become involved in the research process.

**Keywords:** Central America, farmers assessments, multipurpose forages, participatory research

## Subsession 3e: How to Make Technical Innovations Effective

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## **Assessing Technological Innovations for Smallholder Agriculture in the Eastern Amazon Region — Implications for Technology Adoption and Dissemination**

BETTINA HEDDEN-DUNKHORST, MANFRED DENICH, JOHN MBURU, ARISBE MENDOZA-ESCALANTE, JAN BÖRNER

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Over the last four decades smallholder agriculture in the Amazon region continuously adapted to changing economic conditions. This had environmental implications on a local and global scale. In order to reduce pressure on the environment as well as poverty through sustainable production, technological innovations need to be ecologically sound, economically viable, and socially acceptable at the same time. Various research activities currently conducted in the Amazon region investigate the potential of alternative technologies for smallholder agriculture.

The session presents selected findings of a research project carried out by the Center for Development Research (ZEF), University of Bonn, and its Brazilian partners (Embrapa Amazônia Oriental and Federal University of Pará — NAEA, Belém) during the past twelve years. The project developed, tested, and economically evaluated fire-free alternatives to slash-and-burn practices in the eastern Amazon region. The fire-free technologies aim at maintaining the existing fallow system while integrating “modern”, productivity increasing inputs like fertiliser and mechanisation. Fallowing provides important economic and ecological services, such as temporary carbon sequestration and biodiversity conservation, which most technologies for continuous cropping do not accomplish. The presentations first introduce various technologies for smallholders that are currently under investigation. Secondly, a cost-benefit analysis of on-farm trial data highlights the private and social determinants of technology profitability.

Moreover, results of a profit function analysis based on representative farm household data reveal the quantitative importance of fallow as a production factor and the role of fertiliser and product prices in production decisions. Finally, the impact of technology adoption on land use and household welfare is assessed in a set of technology and policy simulations using a bio-economic farm-household model including uncertainty.

The results indicate that the economic impact of environmental degradation is still too low for many farmers to switch from traditional technologies to more sustainable — but cost and/or labour intensive — technologies without substantial government support. Moreover, institutional frame conditions and infrastructure at the municipal

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level favour technological innovation in some districts, while holding it back in others. Especially, in the latter areas, cash and liquidity constraints represent the main obstacle to technological innovation among smallholders.

Concluding remarks reflect on:

1. the research design and the methodological approaches employed in the project,
2. interdisciplinary research that combines ecological as well as socio-economic aspects,
3. and the need to adopt a broader perspective including technological and institutional innovations to stimulate farmers' adoption behaviour.

Finally, a discussion of implications for policy action that arise from the project findings will open the session to a broader debate.

**Keywords:** Bio-economic model, cost-benefit analysis, interdisciplinary research, profit function, technology assessment



# Session 4: Natural Resources Management

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## Managing Plant Genetic Resources in a Sustained Manner in a Quickly Changing Environment

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Approaches to the conservation and use of plant genetic resources have vastly changed over the past twenty years or so. While until the early 1990's the focus was strongly on *ex situ* conservation with a clear emphasis on technologies and the use of conserved germplasm by plant breeders, thereafter this dramatically changed, and people became gradually the focal point of conservation and use activities. Participatory approaches started to become important and a clear shift could be observed with regard to questions related to ownership over the germplasm.

Whereas the common heritage principle was the basis for the exchange of genetic resources until the early 1990's this changed drastically thereafter, triggered by the negotiations of the Convention on Biological Diversity as well as the International Treaty. In both conventions national sovereignty over genetic resources is the basis. The International Treaty stresses the importance that plant genetic resources for food and agriculture are readily available to the users, based on their specific characteristics compared to biodiversity at large, and agreed on the establishment of a multilateral system.

Due to the aforementioned developments national plant genetic resources programmes, including genebanks, started to re-think their role and responsibility in conserving and facilitating the use of genetic resources, in particular by placing the efforts in a much broader context and trying to link conservation efforts with development. The important role of farmers in managing *ex situ* activities. In addition, new technological developments facilitated conservation programmes to adjust to changing environments.

The abovementioned broad changes will be illustrated with concrete examples to demonstrate how the management of plant genetic resources is evolving and in which way sustainability is being addressed, strengthened and/or weakened.

**Keywords:** Conservation and use, ownership, participatory approaches, plant genetic resources, sustainable management

## **Assessment of Incentives for *In-situ* Conservation of African Leafy Vegetables Genetic Resources in Western Kenya**

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In Kenya, important genetic resources include the African Leafy vegetables (ALVs), which are extremely important for food security, nutrition and poverty alleviation. However, the reservoir of these genetic resources is under threat of erosion due to policy emphasis on exotic vegetables. Moreover, scanty or virtually no economic analysis on incentives and species choice behaviour has been conducted. Thus, this thesis focuses on the assessment of various incentives for on-farm conservation of ALVs genetic resources in western Kenya. It has two specific objectives: one, to determine appropriate economic incentives which could be used in policy formulation for on-farm conservation of ALVs, and two, to determine the 'inbuilt' incentives that influence farmers' species choice behaviour. Using a species count diversity index constructed from 207 randomly sampled farm households, the above incentives are determined through an econometric analysis. Favourable market access and farm gate prices have been identified as key economic incentives that would encourage farmers to maintain the ALVs in their farms. Further, it has been documented that farmers' social capital and experience of cultivating the vegetables are 'inbuilt' incentives in the local communities that enhance retention of ALVs diversity. However, increase in labour availability over production period and higher levels of land security are strong 'inbuilt' incentives associated with less ALVs diversity in the study area. Assessing the importance of wild vegetables to the local farmers, it was actually found that these species of ALVs are more threatened by genetic erosion than the cultivated ones. The results of this thesis could be used to promote or inform policy decisions on on-farm conservation of ALVs in western Kenya.

**Keywords:** Assessment, incentives, conservation, African Leafy Vegetable, genetic resources

## **The Importance of Sprouting Ability in Conservation and Development of Ironwood (*Eusideroxylon zwageri* TEIJSM. & BINN.) Varieties**

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Ironwood (*Eusideroxylon zwageri* TEIJSM. & BINN.) is a threatened tree species which grows in tropical lowland forest. Over-exploitation caused decreasing its population. Most of mature trees were felled which leads to decreasing number of seed production and lost of genetic resources. A research on sprouting ability of ironwood varieties had been conducted to evaluate sprouting ability and its importance in ironwood conservation and development. Ironwood varieties have been recognised by local people and also reported by many scientists since in the middle of 19<sup>th</sup> century. Local people recognised four varieties of ironwood which grow in Senami forest, Jambi Indonesia namely daging, kapur, sirap and tanduk. The meaning of those vernacular names is directly related to wood or bark structure of each variety. The research had been conducted at Senami forest using systematic plot survey. Research results obtained that all of ironwood stumps produced sprouts. Sirap was the most dominant variety which sprouting (85.71%) which followed by daging (35.71%), kapur (17.86%) and tanduk (10.71%). The number of sprouts was slightly different from one to another variety. The highest number of sprouts belonged to daging followed by sirap, kapur and tanduk variety. Sprouts tended to grow faster than seedlings. For the first year, they grew 2.87 and 5.64 times in diameter and height respectively. After investigating and discussing sprouting ability of ironwood, it can be concluded that sprouting is very important for ironwood since it faces very intensive threats. It is very important for regeneration, stand restoration, genetic resource conservation, propagation and development of ironwood.

**Keywords:** Conservation, genetic resources, ironwood varieties, sprouts and sprouting ability

## Mechanisms of Susceptibility and Resistance to the Hemibiotrophic Phytopathogenic Fungus *Bipolaris sorokiniana*

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Spot blotch of wheat, caused by the hemibiotrophic fungal pathogen *Bipolaris sorokiniana* (teleomorph: *Cochliobolus sativus*) is a cereal disease of increasing global concern in wheat and barley cropping systems. The pathogen is transmitted through contaminated or infected seeds and can adversely affect germination, development of the root system and above ground plant parts which may kill the seedling within a couple of days. Due to the increasing food demand and limited agricultural land, an effective control of spot blotch needs to be achieved. Hence, the identification of parental stocks possessing an adequate level of resistance to *Bipolaris sorokiniana* is urgently required.

We investigated the interaction of several differentially resistant wheat genotypes to the attack of *Bipolaris sorokiniana* to uncover the mechanism of host resistance. A microscopic dissection of early fungal interaction revealed that fungal penetration into the leaf epidermal layer was stopped either by papilla-like cell wall apposition (CWA) and/or by a hypersensitive reaction (HR) of single cells. Restriction of post-penetration growth of the fungus within a single epidermal cell (biotrophic phase) by a cell death reaction was also observed and termed “post-penetration HR” or “encapsulation”.

In case the fungus successfully overcame epidermal defence, its spreading within the mesophyll tissue (necrotrophic phase) could be restricted by some of the wheat genotypes. The restriction of fungal spreading after successful infection of the host mesophyll tissue was found to be one of the most important mechanisms limiting the emergence of disease outbreak. We discuss the role of fungal toxins as chemical determinants of resistance or susceptibility. These data might be used in strategic breeding programs to build up disease resistance in cereals to hemibiotrophic pathogens.

**Keywords:** Spot blotch, cell wall apposition, hypersensitive reaction, encapsulation, spreading factor, hemibiotrophy

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## Heterotic Grouping of Sudanese Sorghum Landraces

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Sorghum (*Sorghum bicolor*) is the most important grain crop in the Sudanese economy and diet. The Sudan and the adjacent areas in Eritrea and Ethiopia are considered as centres of diversity of sorghum. In Sudan sorghum ranks first in terms of cultivated area (6.4 mill. ha) and production (5 mill. metric tons). However, average yield per unit area is very low (540 kg/ha) in comparison to the world average (1300 kg/ha). The only released sorghum hybrid variety is sensitive to drought and the parasitic weed *Striga hermonthica*. The aim of this study therefore is to characterise the pattern of genetic diversity in a representative samples of Sudanese sorghum landraces and to determine genetically distinct pools which shall serve as base materials for hybrid breeding. Seed samples of 52 landraces from a broad range of the sorghum growing area in Sudan were provided by ARC. Most of the landraces belong to the races durra and caudatum. For comparison, a world-wide collection of 25 inbred lines and 2 wild sorghums (*S. arundinaceum*) were included.

A total of 30 Simple Sequence Repeat markers were employed to establish clusters of potentially heterotic groups. A UPGMA-dendrogram was generated from distance-matrix data using modified Roger's distance. The results show that Sudanese sorghum landraces are highly variable providing abundant diversity for the development of hybrids and open-pollinated varieties. SSR-clustering revealed distinct sorghum landrace groups which are considered as promising base materials for building up heterotic gene pools for the development of high-yielding hybrid varieties. Presently, all landraces and inbred lines will be testcrossed with two Cytoplasmatic Male Sterility lines derived from different gene pools. Individuals of differential clusters will be manually crossed in a diallel manner. The landraces, inbred lines, test crosses and diallel crosses will be evaluated in regular yield trials at three sites in Sudan in 2005 and 2007. Final clustering will be based on molecular markers as well as field data.

**Keywords:** Heterotic grouping, plant breeding, sorghum, SSR, Sudan

## Salt Tolerance of Main Sorghum Genotypes for Salt Affected Soils of Sudan

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Arid and semi-arid conditions contribute to more than 50 % of the total coverage of Sudan. One of the main crops that is found suited such climatic conditions, is *Sorghum bicolor* which is considered as the main food of more than 70 % of the population. Salt affected soils contribute to more than 26 % of the total cultivated land that in addition to many indicative signs of secondary salinisation creep from North to South. Chemical treatments together with leaching of salts are found to have many restrictions due to the heaviness of most salt affected soils and some problems related to water availability. To attain sustainable sorghum production under such above mentioned conditions, six sorghum genotypes were tested on soils with different levels of salt concentrations. Other than the control the levels were 2, 4, and 8 dS m<sup>-1</sup> in the saturation extract, the treatments were selected comparatively to the natural prevailed conditions of the semi-arid habitat. For artificial salinisation NaCl was used because NaCl is found to be the dominant salt in the salt affected soils of the semi-arid conditions of Sudan. The sorghum genotypes selected for this study were ICSV 207, ICSV 112, F.W. Ahmed, Ingaz, PSV 16 and Tabat. The treatments were arranged in a Complete Randomised Block Design with four replications (pot experiment). The preliminary results showed varietal differences in response to different levels of salt for both tested yield components: grain yield and biomass. The key findings of this study are: 1. The tested genotypes were ranked from tolerant to sensitive as to the varietal significant differences in biomass as follows: F.W. Ahmed, ICSV 112, PSV 16, Ingaz, Tabat, ICSV 207. 2. The tested genotypes were ranked from tolerant to sensitive as to the varietal significant differences in grain yield as follows: ICSV 112, ICSV 207, Tabat, PSV 16, Ingaz, F.W. Ahmed.

**Keywords:** Arid conditions, salt affected soils, salt tolerance, sorghum



## Contrasting Adaptation to Drought Stress in Wild Populations of *Coffea arabica* in Southwest Ethiopia

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Because of the recently reduced profits in coffee production, cultivation area shifted to marginal sites in order to keep pace with low prices. The results are drought and temperature stress due to the extremely narrow genetic pool of the cultivars used in breeding. Consequently, breeding of coffee genotypes with improved tolerance to drought is becoming an acute issue and a more detailed understanding of the mechanism underlying drought tolerance in arabica coffee is needed.

Therefore, a study is being carried out to analyse drought tolerance strategies in four wild populations of *Coffea arabica* along a precipitation gradient at its place of origin and centre of diversity, in Ethiopia. There, *Coffea arabica* shows a wide ecological distribution as well as a certain tolerance to drought due to the dry season in this region.

It was hypothesised that the rainfall gradient would create distinct selection pressures for traits related to water use and promote regional differentiation in adaptation to drought stress. In order to identify the physiological mechanisms responsible for drought tolerance (**i**) ecophysiological differences due to soil water availability, (**ii**) tolerance to progressively increased soil drying and (**iii**) the influence of genetic variation on any phenotypic variation observed in field grown plants is assessed.

Changes in gas exchange, water potential and carbon isotope discrimination were studied during a single year's dry and wet season. To examine variations among and within different provenances, measurements have been carried out under field conditions. The results of this study are presented.

This study forms part of the ZEF-Project "Conservation and use of the wild populations of *Coffea arabica* in the montane rainforests of Ethiopia (CoCE)".

**Keywords:** *Coffea arabica*, Ethiopia, forest coffee, water relations

## The Potential of Neglected Fruit Trees of Ucayali Department of Peruvian Amazon

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In terms of biodiversity, Peru is among the three richest South American countries, along with Brazil and Colombia. Amazonia has supplied a number of important crops for world agriculture and can still offer many more if scientific research and entrepreneurial action are directed towards this end. Approximately 0.5 % (350 000 ha) of the Peruvian Amazon is converted to cropland or pastures each year, with greatest rates of deforestation occurring around population centres, such as Pucallpa, the capital of Ucayali region.

The fruit diversity of Amazon basin is far from exploited. More than 100 different fruits compose the offer of the traditional markets of the continent and the present inventory includes more than 1100 native American fruits, at all stages of domestication, some still collected in the wild, while some of their successful relatives are cultivated intensively. These locally important species are frequently neglected by science. Lack of attention by research and development has meant that their potential value is under-exploited. This neglect status places them in danger of continuing genetic erosion, further restricting development options for the rural poor. Research to increase their value and make them more widely available would broaden their resource base and increase the livelihood options for rural communities.

Although, some of the indigenous species have been promoted and researched, there exist numerous neglected fruit crops, such as *Pouteria speciosa*, *Maxmilliana marida*, *Couma utilis*, *Paraqueiba sericea*, *Plukenetia volubilis*, *Scheelea basleriana*, *Theobroma bicolor*, *Theobroma grandiflorum*, *Crescentia cujete* etc. which are not yet fully domesticated and important ethnobotanical data still remains unknown.

Native fruits present unique opportunities to widen or re-conquer domestic markets, to diversify agricultural production and for the sustainable development of particular areas, as the fragile ecosystems of the Amazon basin.

The objective of this study was to emphasise the genetic diversity and multipurpose use of neglected crops (especially fruit trees) of Ucayali department in connection with appropriate ethnobotanical data through participatory on farm research. Subsequently, germplasm collection was established in cooperation with Universidad Nacional de Ucayali for further selection and return distribution to local farmers.

**Keywords:** Amazonia, fruit species, neglected crops, Peru

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## ***Pueraria montana* — Genetic Diversity of a Neglected Crop in North Vietnam**

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*Pueraria montana* (LOUR.) MERR. (kudzu) is a neglected crop with a long history of cultivation and ethnobotanical uses in Asia. Its potential as forage and soil cover crop as well as its close relation to soybean has stimulated research aiming at conservation of germplasm, plant improvement, and breeding programmes. Nevertheless, little is known about genetic diversity of this species. However, such information is key to efficient collection, sustainable utilisation, and appropriate conservation strategies of plant genetic resources. The objective of this study was to develop an appropriate molecular marker based methodology to analyse the genetic variation of five *P. montana* accessions collected in Bac Kan province, North Vietnam, in order to gain a basic understanding of genetic differentiation patterns in the target region. Using RAPD markers, *P. montana* presented a high level of variation with 54.3% of the detected markers being polymorphic and a mean JS coefficient that amounted to 0.35. The UP-GMA dendrogram showed that *P. montana* accessions clustered in congruence with their eco-geographical origin i.e. genetic diversity increased with geographic distance or coincided with topographically isolated collecting sites. The high level of differentiation among *P. montana* accessions suggested that variation was mainly distributed among accessions rather than within accessions. Thus further collections should take place at larger distances or in diverse environments where isolation by distance or by natural barriers can be expected, and in addition, should focus on sampling small numbers of individuals from many different populations rather than intensive collecting of only few populations. The results of this study indicate that the RAPD technology is highly informative and thus represents an effective tool to generate molecular markers in *P. montana*. Generated data serve as a reference point for further collecting and research on this species.

**Keywords:** Genetic diversity, kudzu, molecular markers, North Vietnam, plant genetic resources conservation, *Pueraria montana*

## QTL Analysis for Salt Tolerance in Barley

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Salinity is an important limitation to crop production in many agricultural systems and worldwide vast areas of arable land are lost every year to salinisation, particularly in arid regions. Management options are needed to sustain agricultural use of affected areas, to decrease famine hazards, and to reclaim saline soils. Those options include genotypes sufficiently resistant to salinity to off-set the farmers' investment in reclaiming the land.

Varying degrees of salinity tolerance have been observed in many plant species, with barley being one of the best-known salt tolerant crops. The physiology of salt stress has been intensively investigated for various crops, but relatively little is known about the number, the location and inheritance of genes that are responsible for higher salt tolerance. Linking the physiological with the genetic information is a major objective of modern plant breeding. The objective of this study is to detect the genetic basis of salt tolerance traits in barley (*Hordeum vulgare* L.) using a number of Afghan barley cultivars and the Oregon Wolfe Barley (OWB) mapping population, well saturated with molecular markers for QTL mapping. Afghanistan soils, like in many other countries in semi-arid regions, suffer from soil salinity on a large scale. Salt tolerant barley grown as forage grass may provide a basis to control both soil erosion and salinity while providing some benefits for cattle production.

Initial tests with different NaCl concentrations revealed that the germination process of the OWB population was highly responsive to the salt concentration and genotypes varied substantially in their susceptibility to salinity. Following the QTL analyses, field trials in Afghanistan are planned to validate the trait loci identified in the initial tests and to identify local genotypes carrying desired traits for both cultivation and breeding.

**Keywords:** Afghanistan, erosion control, gene mapping, *Hordeum vulgare*, oWB, plant breeding, soil salinity

## Identification of a Core Collection in *Desmodium ovalifolium* Based on Marker Data

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“*Desmodium ovalifolium*” is the abbreviated and most commonly used name for the taxonomically valid name *Desmodium heterocarpon* L. DC. subsp. *ovalifolium* (PRAIN) OHASHI. This species originates from Southeast Asia, namely Thailand, Cambodia, Laos, Vietnam, Malaysia, Indonesia and the Philippines. Since it is well-adapted to the acid, low-fertility soils of the humid tropics and has low nutrient requirements, *D. ovalifolium* has a high potential to be used as multi-purpose legume (e.g. soil cover, forage) in tropical production systems. The actual world collection of *D. ovalifolium* accessions is maintained in the CIAT genebank and basic passport data are available. However, little is known about the genetic structure of this collection. Therefore, as an initial step the random amplified polymorphic DNA (RAPD) technique was adjusted for *D. ovalifolium* and a total of 100 primers was tested. Twelve of these decamer primers were informative and yielded 18 polymorphic fragments. Based on the obtained data, Jaccard similarity (JS) coefficients were calculated for 146 accessions and a dendrogram was generated by means of the unweighted pair group method (UPGMA). Analysis of the clusters showed no correlation between ecogeographic origin and grouping of the accessions. Besides, a large number of accessions showed identical banding patterns leading to the assumption that some of them are probably duplicates of the same genetic material. In order to provide a structured sample from the collection and to reduce the number of accessions to a more manageable size for further research, the maximisation strategy was used for generating a tentative core collection consisting of 20 accessions. The combination of these accessions maximises the number of observed alleles at the marker loci in the core while keeping the total number of accessions to a specific limit and ensuring a minimum number from every group.

**Keywords:** Core collection, *Desmodium ovalifolium*, RAPD

## ***Stylosanthes* — An Underexploited Tropical Legume Genus?**

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The primary importance of *Stylosanthes* – probably the most widely used tropical forage legume genus – lies in the particular potential of most species for marginal conditions, due to their adaptation to low-fertility soils and drought. There are about 40 species, among them the well-researched *S. humilis*, *S. guianensis*, *S. hamata*, *S. scabra*, *S. capitata*, and *S. macrocephala*.

The current importance of *Stylosanthes* is reflected by numbers of cultivars and of hectares sown, and volumes of seed produced. So far, there are more than 30 formally released and informal cultivars, mainly within the aforementioned species. Many of them, however, have never been used to any significant extent. *Stylosanthes* is particularly important in Australia, tropical China, India, Thailand and West Africa. It is used for grazing in mixtures with grasses or in fodder banks, for improvement of communal grazing lands, and increasingly also for leaf meal production. The main production-limiting factor is anthracnose. Lack of both continuity in research and effective extension mechanisms has also constrained further variety development and adoption.

The potential importance is defined by the inter- and intra-specific variability. *Stylosanthes* species have a wide natural distribution, are highly polymorphic and show mechanisms of adaptation to the most variable environments and ecological niches. Available *Stylosanthes* germplasm constitutes the world's largest collection of a tropical forage legume, the vast majority of accessions belonging to the aforementioned species. Of those, the potential of *S. humilis* and *S. capitata* has not yet been explored adequately; they deserve a research revival. A number of *Stylosanthes* species are still essentially unknown to agronomists and are poorly or not at all represented in germplasm collections. However, because of particular, promising characteristics, they are considered worth of germplasm collection and evaluation efforts, such as *S. fruticosa*, *S. leiocarpa*, *S. mexicana*, *S. sericeiceps* and *S. sympodialis*. Other, though not particularly productive, species deserve attention as potential source of genes for breeding programs such as *S. angustifolia*, *S. bracteata*, and *S. tuberculata*. As a successful example from Brazil shows, unconventional variety development approaches should be considered as should participatory research with farmers and uses other than for grazing.

**Keywords:** Cultivars, current importance, forage legumes, genetic resources, potential importance, *Stylosanthes*

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## Subsession 4b: Sustaining Plant Diversity

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## Worldwide Assessment on the Sustainable Use of Medicinal and Aromatic Plant Species

RAINER SCHLIEP

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In 2003 a survey on the sustainable sourcing of Medicinal and Aromatic Plant (MAP) species was initiated by WWF Germany, the German branch of WWF - World-Wide Fund for Nature, and TRAFFIC Europe. The TRAFFIC (Trade Record Analysis of Fauna and Flora in Commerce) network is the joint wildlife trade monitoring programme of WWF International and IUCN - the World Conservation Union. TRAFFIC's mission is to ensure that trade in wild plants and animals is not a threat to the conservation of nature.

The main objective of the survey is to support and promote the development of internationally binding standards and criteria for the sustainable sourcing and use of MAPs. The revision of the 1993 WHO/IUCN/WWF Guidelines on the Conservation of Medicinal Plants and the current development of the WHO Guidelines on Good Agricultural and Collection Practices (GACP) for medicinal plants are processes that are intended to profit from the results of the survey. The intention is that both the negotiations on the international level and the projects on local or regional level mutually benefit from the experiences gained. The initial step was the establishment of a worldwide register of at present more than 70 projects that are focused on the sustainable sourcing of MAPs. Around 30 of these projects were selected for an in depth analysis. The analysis is focused on the challenge of integrating social, economic and ecological aspects for a sustainable conservation approach. A questionnaire with 41 questions concerning social, economic and ecological aspects as well as communication and capacity building and institutional and legal aspects was elaborated and distributed among the selected projects. The conceptual background for the questionnaire was provided by the Ecosystem Approach (EsA). The EsA is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It is the primary framework for action under the Convention on Biological Diversity (CBD). More than 15 projects from Africa, Asia, Europe and Latin America answered the questionnaire. The analysis of the feedback and an evaluation of the results will be presented at the Conference.

**Keywords:** *In-situ* conservation, medicinal and aromatic plants, nature conservation, poverty alleviation, traditional health-care

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## Structure and Diversity of Ecosystems as a Tool for Forest Resource Management

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The structure of a forest may be defined by the spatial distribution of the tree positions, by the spatial mingling of the different tree species and by the spatial arrangement of the tree dimensions. The spatial structure is one of the characteristic attributes of a forest, the problem is to characterise and describe forests with different spatial characteristics more accurately, using affordable assessment techniques.

Characterisation of forest ecosystems structure must be based on quantitative indices that allow objective analysis of human influences or natural succession processes. The objective of this study is the compilation and assessment of diverse quantitative variables to describe structural attributes and diversity from the arboreal stratum of the ecosystem, as well as different methods of forest inventory to obtain such indices. For the evaluation of the species structure and diversity the Indices of Shannon  $H'$ , Species Profile A, Segregation S of Pielou and the Species Mingling Index  $M_i$  are discussed. The Aggregation Index R of CLARK & EVANS and the Contagion Index  $W_i$ , were include in order to describe the horizontal structure of the ecosystem. Finally, for the characterisation of the dimensional structure, the Homogeneity Coefficient H, and the Indices of Diameter Differentiation  $TD_i$ , Height Differentiation  $TH_i$  and the tree attribute Dominance of Neighbours  $U_i$  were analysed.

Case studies of detailed analysis of forest spatial structure and diversity in the Federal States of Durango and Nuevo León, Mexico, are presented. The selected variables describe the distributions of spatial mingling, size differentiation and contagion, which can be easily interpreted allowing quantitative comparisons between complex forest structures. The application of such indices in an integral method of forest inventory allows a better description and reproduction of the ecosystems, as well as the development of indicators of sustainability of forest resource management.

**Keywords:** Biodiversity, contagion, diameter differentiation, mixed stands, species mingling

## Effects of Different Land Use Intensities on the Succession of Secondary Forest in the Protected Forest Sumaco, Ecuador

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Studies on site and forest history provide many useful insights into the effects of human activities on Neotropical forest structure and functions. However, we are still unable to develop a deterministic model to simulate how land use history influences tropical forest structure and succession. The present study aims to enhance our ability both to predict and to manage tropical forest succession. Three forest sites (Rukulacta, Villano and Wawa Sumaco) with different colonization date and use intensity were selected. The age of the forest ranges from 3 and 22 years. At each site, plots of 500 m<sup>2</sup> surface (20 × 25 m) were installed with four repetitions. Within the plots, all trees above 5 cm DBH were identified and measured. According to the results, a regional model was developed to determine the driving factors of secondary forest succession. The number of occurring species depends on the sample area, stand age and land use intensity. The species/area curves of the different sites differ significantly; a correlation between land use intensity and species richness could be observed. Multivariate analysis procedures (Principal Component Analysis) were used in order to determinate the patterns of species replacement and show that land use affect floristic composition following abandonment. A noticeable floristic affinity exist, with an intensive land use in different phases of succession. Stand structure analysis showed differences in aggregation and desegregation due to the succession. The DBH distribution (Weibull function) of the forests is influenced by the grade of anthropogenic disturbance. The Correspondence Analysis is used for describing the potentiality of the Secondary Forest in different sites. The forests under middle and low intensity of the use, the commercial species exceed 38 % in comparison with the forests exhibiting high intensity of use.

**Keywords:** Correspondence analysis, neotropical forest, land use intensity , Weibull function, principal component analysis, regional models, Ecuador, biodiversity index

## **Impact of Rangeland Degradation on the Food Security of Borana Pastoralists in Southern Oromia, Ethiopia**

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Rangeland condition assessment was conducted in the Borana lowlands, Ethiopia to determine the current status and future trend of the grazing land with emphasis on comparing different functional land use units called Kalo, Worra and Foor. An approach that integrated soil, herbaceous and woody plants of the rangeland was followed. Density and frequency of woody plants were determined in 123 plots of 500 m<sup>2</sup>, whereas, scores of grass species composition, basal cover, litter cover, number of grass seedlings, grass age distribution, soil erosion and compaction were recorded from 615 subplots of 0.25 m<sup>2</sup>. Furthermore, relationships between rangeland condition score and herbaceous biomass production, percent bare soil, and density, frequency and percent cover of woody plants were determined by applying multivariate analyses. The overall rangeland condition appeared to be in a transitional state from good to poor with a downward trend. Principal Components Analysis (PCA) and Redundancy Analysis (RDA) illustrated that woody plants were negatively correlated with rangeland condition score, botanical composition and basal cover of grasses. Low score of grass composition, low herbaceous biomass production and increased woody plants cover were some of the indicators of rangeland deterioration. Woody plants encroachment, lack and/or shortage of rain, and ban of rangeland burning were among the major factors that caused rangeland deterioration. Rangeland degradation directly affects livestock production on which the livelihood of Borana pastoralists depends, resulting in food insecurity and ecological instability. Therefore, rangeland rehabilitation, re-utilisation of fire as a range management tool, and selective clearing of woody plants are recommended as a result of this study.

**Keywords:** Borana lowlands, food insecurity and botanical composition, rangeland condition and trend

## **Production and Consumption Issues of Traditional Vegetables in Tanzania from the Farmers Point of View**

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Traditional vegetables, though not necessarily indigenous to a country, can be associated with traditional production systems, local knowledge of farmers, and usually, have a long history of local usage and selection. Traditional vegetables are widely underutilised and neglected in research and development. In the frame of the project Promotion of Neglected Indigenous Vegetable Crops for Nutritional Health in Eastern and Southern Africa led by the World Vegetable Centre (AVRDC) and partners, a study was performed in order to verify the potential of traditional vegetables that might help to fight malnutrition in Tanzania and to diversify income for resource-poor farmers under low-input conditions.

For this study, focus group meetings were conducted in 10–12 villages of four different districts in north-east Tanzania to gather basic information on available traditional vegetables and to explore farmers' knowledge on production and consumption taking gender into consideration. The four districts differed highly in ethnicity as well as in climate, altitude, and soil conditions.

Farmers named 10–34 different traditional vegetables per village, summing up to an overall of 102 in all four districts. While 56 of these vegetables could be identified, 46 of them were only known by their local names. Only 12 traditional vegetables were present in all four districts. The number of wild traditional vegetables used was always greater than that of cultivated ones, with a ratio wild:cultivated ranging from 11:9 in an urban highland district to 59:11 in a rural coastal district. However, wild vegetables were threatened with genetic erosion due to change in land use and eating habits. Despite their recognised importance, existing taboos, for example in one district, did not allow men to eat green leafy vegetables. Preservation of traditional vegetables was non-satisfying since leaves were usually dried in the direct sun-light, whereby especially vitamin C is being lost.

As a consequence of this study, it is suggested i.a. to launch an educational programme especially on sparing preparation and processing methods as well as to increase awareness of wild traditional vegetables, the conservation of their habitats, and the possibility to save these genetic resources through enhanced utilisation.

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**Keywords:** Genetic diversity, indigenous knowledge, Tanzania, traditional vegetables, wild vegetables

## The Role of Pathogens as Natural Biological Control Agents of *Parthenium* Weed in Ethiopia

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*Parthenium* is an exotic invasive weed that originated in tropical America, now occurs widely in India, Australia, and Africa. In Ethiopia, it is also known to affect crop, animal and human health. *Parthenium* was observed growing in different habitats from hot, arid and semi arid low altitude (912 m.a.s.l.) to humid high mid altitude (2500 m). Experiments on diagnosis, incidence and distribution of pathogens associated with *Parthenium* and further evaluation of the potential pathogens as bio-control agents were carried out from 1998–2002. Several fungal isolates of the genus *Helminthosporium*, *Phoma*, *Curvularia*, *Chaetomium*, *Alternaria*, and *Eurotium* were obtained from seed and other plant parts of *Parthenium* although the isolates tested were non-pathogenic except *Helminthosporium* isolates. The two most important diseases associated with *Parthenium* were the rust, caused by *Puccinia abrupta* var. *Partheniicola* and the phyllody, caused by phytoplasma of fababean phyllody group (FBP). The rust was commonly found in high mid altitude (1400 — 2500 m.a.s.l.) with disease incidence up to 100 % in some locations while phyllody was observed in low to mid altitude regions (900 — 2300 m.a.s.l.) of Ethiopia with up to 75 %. Individual effects of the rust and phyllody diseases on parthenium in different locations under field condition showed that weed morphological parameters were significantly affected. Seed production capacity of *Parthenium* was reduced by 42 and 85 % due to rust and phyllody, respectively. Host specificity tests against the weed and crop hosts related to *Parthenium* revealed that sporulation of *P. abrupta* was observed only on *Parthenium* though limited number of poorly developed pustules were recorded on varieties of niger seed. Phyllody and rust diseases of *Parthenium* showed significant potential for use as a classical biological control.

**Keywords:** Ethiopia, non-obligate fungi, *Parthenium*, phyllody, rust

## Species Diversity in Remnant Natural Forests of Timber Plantations in Ghana

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Tropical forests are biologically the richest ecosystems in the world but the conversion of tropical forests into plantations of mostly exotic tree species is widely practised and threatens the continual existence of native tropical trees. As a perspective, it is envisaged that remnant natural forests will be conserved to act as important reservoirs of native flora and fauna within extended plantations. The Institute for World Forestry of the Federal Research Centre for Forestry and Forest Products in collaboration with the International Center for Graduate Studies of the University of Hamburg and Du-Paul Wood Treatment Ltd., Ghana is undertaking field research in forest plantations of the Ashanti region in Ghana. The objective of this study is to assess the ecological status of natural forest fragments and the regeneration potential for the sustenance of native tree species and possible enrichment of exotic tree plantations. A full sampling method was used for the assessment of trees with a DBH  $\geq$  10 cm, while a systematic sampling method was used to assess the tree regeneration. In this regard mammal and bird surveys were carried out to determine their potential as seed dispersers. The full sampling of two distinct natural forest patches revealed a total of 224 living trees belonging to 26 species and 13 families. The regeneration study recorded a total of 47 tree species representing 20 families of trees. Birds and mammals amongst other seed dispersal vectors account for the increased number of tree species in the regeneration stages. A bird survey with the point count method was used to compare the diversities of birds in the different vegetation strata on the plantation: Remnant natural forest, afforested sites and a neighbouring agroforestry area. The agroforestry area recorded the highest bird diversity (Shannon index) of 2.074 while the remnant natural forest and the afforested sites showed approximately the same diversity level (1.693, 1.682 resp.). A survey of important seed dispersing mammals (including 3 bat species) showed that 14 species exist in and around the plantation indicating also that, mammals play an important role in seed dispersal of the native flora.

**Keywords:** Diversity, plantation, regeneration, remnant natural forest

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## Subsession 4c: Exploring and Sustaining Animal Genetic Resources

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## Gene Flow in Animal Genetic Resources — A Study on Status, Impacts, Trends

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Animal migration and exchange has always taken place, but at present development of modern breeding methods, advances in trade, transportation, communication and a trend to uniformity of breeding goals increasingly foster the exchange of breeding animals and material. Quantitative data on the exchange of livestock genetic resources between the various regions of the world is lacking. The advantages and disadvantages of gene flow for stakeholders have not yet been assessed although stakeholders argue that animal genetic resources are being used without sharing of benefits. An overview of the current status of exchange of genetic material is required to draft policies and programmes at national, regional or global level.

In a global study the historical development of gene flow will be shown and the influence of artificial insemination and other reproduction techniques and changes in breeding organisation on the dissemination of breeds will be described. Based on the indications of the global study, several case studies will then seek in-depth information on selected breeds and regions about impacts of gene flow. The advantages and disadvantages of gene flow for different stakeholders and its effect on agro-biodiversity will be analysed. Sources of information will be international statistical trade records, project reports, publications and expert interviews.

Beneficiaries of the study political decision-makers, farmers, pastoralists and breeders, particularly in developing countries, relevant international bodies and donor institutions who are provided with a policy support tool for negotiations on Access Benefit Sharing, for assessing the need for an international agreement on livestock genetic resources and for regulating livestock genetic transfer in the frame of the currently in FAO discussed “Global Strategy for the Management of Animal Genetic Resources”.

International legitimacy is aspired by a multi-agent approach. The study is implemented by the Institute of Animal Production in the Tropics and Subtropics of the University of Hohenheim and commissioned by BMZ/GTZ. FAO acts as a support agency. An advisory panel composed of international scientists, representatives of donor and development agencies, the private sector and NGOs accompanies the study.

**Keywords:** Animal genetic resources, biodiversity, breeding animals, gene flow, policy support, semen trade

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## Assessment of Farmer Preferences for Cattle Traits in Smallholder Cattle Production Systems of Kenya and Ethiopia

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There is an urgent need to improve livestock productivity in sub-Saharan Africa in order to keep pace with expected increases in demand for meat and milk. Breed improvement provides key entry points for increasing productivity in cattle populations. However, there are tendencies for genetic improvement programs to focus on single, market driven traits such as milk or meat production in isolation of environmental constraints and broader livestock system functions which cattle perform in developing countries. This potentially leads to genotypes not well adapted to the environment and not capable of performing the multiple roles that cattle assume in smallholder systems. In developing countries, many important functions of livestock are embedded in traits that are not traded in the market. These include functions and products such as traction, manure, form of security (insurance), dowry payment and use in traditional ceremonies.

This study evaluates preferences of cattle keepers in pastoral, agro-pastoral and crop-livestock systems of selected sites in Kenya and Ethiopia for various cattle traits. Participatory Rural Appraisal (PRA) ranking techniques and conjoint analysis methodology are used. These systems are characterised by low input management and prevalence of various cattle diseases. Trypanosomosis is a serious disease constraint in Ghibe valley of Ethiopia and some of the pastoral areas in Kenya. The results indicate that farmer preferences for cattle traits are influenced by various factors including production system characteristics, infrastructural constraints, farmer characteristics and environmental conditions, especially in relation to disease prevalence and availability of cattle feeds. In the crop-livestock systems of Ghibe valley in Ethiopia, important cattle traits include trypanotolerance, reproductive potential and fitness to traction. Milk production is a less important trait. On the other hand, in the pastoral and agro-pastoral systems of Kenya, important traits include milk production, reproductive potential, drought tolerance and fertility in bulls. Consequently, implications for policy are drawn.

**Keywords:** Cattle production system, conjoint analysis, Ethiopia, Kenya, trait preferences

## Open Nucleus Cattle Breeding Programme in the Lake Victoria Crescent Region of Uganda

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The Poverty Eradication Action Plan (PEAP) is Uganda's comprehensive development framework with one of its most important pillars being the Plan for Modernisation of Agriculture (PMA). PMA aims at accelerating agricultural growth through transforming subsistence modes of agricultural production to commercial ones. Livestock is an important sub-sector in agriculture contributing 7.5 % and 17 % to total GDP and agricultural GDP respectively. The pathetic per capita availability of livestock products in the country viz. 40 litres of milk and 5.6 kgs of meat as compared with the FAO recommendation of 200 and 50 respectively calls for sustainable PMA compliant interventions in the sub-sector. Although animal genetic improvement offers one of the most powerful and cheapest means of improving farm productivity, its effective exploitation has been hampered by lack of well planned and executed breeding programmes. The National Animal Genetic Resources Centre and Databank (NAGRC&DB) which has the mandate to oversee animal breeding activities in the country is therefore, trying to put a systematic cattle breeding programme in place. Because of its suitability in low-input low-output systems, the Open Nucleus Breeding strategy has been chosen to play a leading role in the genetic improvement of cattle. It is a scheme where superior animals are multiplied at a central farm, distributed to farmers and the best animals from the farmers are brought back to the central farm for further breeding and the best bulls recruited for semen production in the Bull stud. Nshaara stock farm, which is found in South Western Uganda, is to spearhead the improvement of the prevalent Ankole (local) cattle population. The centrally located Njeru stock farm is to take lead in the improvement of the Holstein-Friesian population. The essence of this study is to evaluate a range of Open Nucleus designs (genetical and operational) from which the best ones will be recommended for execution. The study covers the Lake Victoria Crescent region in Uganda, a region with an on-going Herd/Milk Recording Scheme which has provided much of the data used in the study. SelAction (computer programme) which uses deterministic simulation will be used in the evaluation of the different designs.

**Keywords:** Animal breeding, cattle, livestock, open nucleus, Uganda

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## Set up On-farm Performance Testing Schemes as a Component of Village Breeding Programs for Pigs in North Vietnam

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In the mountainous regions of North Vietnam, smallholders progressively try to extend livestock husbandry, since cropping activities are increasingly limited by high land pressure. Low and unsteady resource availability limits intensification possibilities; therefore, production efficiency must be increased through improved resource utilisation, especially through sustainable livestock breeding/management programs, to avoid resource mining by keeping inappropriate genotypes. No such livestock breeding/management programs exist yet for resource poor smallholder systems. This study presents on-farm performance testing schemes established as first step in the set-up of village breeding programs for pigs. Comparative performance testing for higher-yielding Mong Cai pigs, indigenous Ban pigs and selected crossbreeding groups will allow identifying genotypes with high productive adaptability for different production environments. Organisational structures required for breeding programs are established on village level. On a long-term basis, integration of Ban and Mong Cai pigs in a stratified village breeding programme is envisaged.

A pilot phase from March to June 2003 in two villages of ethnic Black Thai in Son La province aimed on investigating suitable on-farm research methods, selecting parameters for on-farm performance testing conducted by farmers, developing a data recording/management system, training farmers in using a herd management software, and setting up a long-term stable data flow system between farmers and researchers.

The working concept was introduced in participatory farmers' meetings. Vietnamese-language datasheets were developed and distributed to farmers. A first round of data collection by farmers and back-checking data by researchers was conducted. Distributing datasheets for the following month ensured continuation. Participatory feedback seminars aimed on evaluating performance-testing schemes established and on making performance testing results applicable for farmers. A project databank was set up using PigChamp (herd management software), selected farmers received training on its use. In the databank, pigs of each village are considered as one herd, allowing for analysis on animal, household, and village level.

As a result, on-farm performance testing by farmers was successfully implemented. Future activities aim on improving completeness/accuracy of data collection and detaching farmers' participation from compensations. This contribution presents the performance testing approach and preliminary evaluation results and describes the organisational structures established.

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**Keywords:** Local pig breed, on-farm performance testing, Vietnam, village breeding program



## Characterisation of the Production System of the Jabali Goat in Syria

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The Syrian goat population amounts to approximately 1 million head. Goats are distributed all over the country, but found particularly in the mountains of Western and South of Syria. The predominant goat type (breed) in these regions is called Jabali goat. Little is known about the characterisation of this goat and the associated production systems. A study was designed to characterise the production system, identifying major constraints, assess the role and contribution of the Jabali goat to the livelihood of poor farmers and obtain a phenotypic description of the goat. Two study areas were identified: Al Ghab near the city of Hama, in northern Syria, and Al Sweida in the far South. In each area participatory workshops (PWs) were held separately for women and men farmers in view of previous information on labour division. In the PWs participatory rural appraisal tools and methods such as mapping, seasonal calendar building, ranking and design of problem trees, were used. The PWs were followed by individual visits to 20 farmers in each of the two areas described above, interviewing separately women and men on the basis of a simple questionnaire. During these visits the herd structure was inspected, the health status assessed, and body measurements and fibre samples were taken from 5 to 10 adult animals per herd. For most families goat keeping was not the only source of income. Main reason for keeping goats was milk production. The milk is transformed in traditional products including yoghurt and yoghurt derivatives, and ghee (butter). Major production problems identified by farmers involved shortage of grazing areas, disease control and marketing of dairy products. The milking season starts in March or April and lasts until September. A strict labour division is followed in the production cycle. Men and boys work as herdsmen, whereas women are responsible for milking and milk processing. The Jabali goat is of medium size with short to medium long ears and a straight nose profile. The coat colour varies and could be entirely black, brown or white. Black is the predominant colour.

**Keywords:** Jabali goat, phenotypic description, PRA, production system, Syria

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## **How to Compensate Pastoralists for Conserving the Borana Cattle in Kenya and Ethiopia**

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The Borana cattle in northern Kenya and southern Ethiopia have unique traits that make them suitable for the harsh environment in the lowlands and have ever been part of the pastoralists' identity. Borana cattle are also the main source of the pastoralists' income. Nowadays the certainty of this income is in jeopardy due to genetic erosion and dwindling number of pure Borana animals. This depletion of the breed has many driving factors such as population pressure, ecological changes, natural catastrophes and adverse economic conditions. Conservation efforts of these important animal genetic resources (AnGRs) by governments and other stakeholders would ensure not only the well-being of the pastoralists but also prevent losses in genetic materials for future use. At the moment, there are no compensatory mechanisms targeting pastoralists.

This paper tackles various questions related to compensation strategies for Borana cattle, e.g. which type of the Borana breed should be maintained, which regions and which pastoralists should be involved and how much should be the level of compensation. The empirical data analysed in this paper was collected through interviews of Borana pastoralists in Ethiopia and Kenya. The pastoralists were asked about their attitude towards the importance of different cattle breeds and towards compensation payments as well as about their awareness for a change in the traditional cattle management. In order to reveal differences within the breed, phenotypic characteristics were measured in different regions. Finally, conservation priorities were given accordingly to pastoralists' preferences and attitudes, the degree of "pureness" of the Borana cattle and the conservation costs.

**Keywords:** Animal genetic resources, Borana cattle, compensation payments, costs of conservation, phenotypic traits

## **Adaptive Traits and Characterisation of the Production System of Local Chicken in Jordan**

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In Jordan, chicken production depends mostly on large-scale commercial systems. The total chicken population was estimated to be 24 millions of imported commercial breeds and one million of local chicken. The local chicken are prevailing in rural areas. In Jordan no studies were carried out to characterise, to evaluate, to understand and to develop the free-range chicken production system. Instead, the prevailing locally adapted poultry populations were substituted by imported high-input and high-output strains, which became very popular for commercial production ranging from medium to large scale operations. Disease and heat tolerance are remaining major constraints affecting the efficiency of production. The free-range scavenging system based on local breeds could provide an alternative source of income and nutrients for poor people. Further, the local chicken population represents presumably an important genetic reservoir for adaptive traits. Therefore, it is important to maintain access to the adaptive genetic potential of local breeds and to prevent further loss of genetic resources. To achieve this target, the system and the chicken population must be characterised. The study aims to estimate the potentials of the local chicken production system, and to investigate the local chicken adaptive traits. The study will be based on: **(1)** Analysis of the production system; **(2)** On-farm and on-station phenotypic characterisation of the local chicken and their productive and reproductive potentials; **(3)** Comparative studies of disease tolerance between commercial and local breeds. Field data will be obtained by using participatory rural appraisal (PRA) approach, structured questionnaires, and involvement of the farmers in the study. Disease challenge experiments and laboratory techniques will be carried out to investigate the adaptive traits. The development of appropriate breeding and conservation programmes will be one possible outcome of this study.

**Keywords:** Adaptive traits, disease resistance, Jordan , local chicken

## Valuing Functions and Losses of Scavenging Local Chickens in Rural Communities of Malawi

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A twelve months monitoring study was conducted on household flocks of scavenging chickens in 27 villages in central Malawi. The objective was to identify and value functions and losses that involved physical migration of growing and adult chickens out of household flocks. Household flock dynamics and their causes were recorded during the weekly visits on farmer households. Annual flock values were quantitatively determined from information of monthly flock sizes and outputs, their live weights and farm-gate prices.

Primary functions of chickens were in that order of importance: household consumption (28 % of overall offtake), consumption in ceremonies (14 %), goods for sale (9.4 %), exchange of breeding stock (4.0 %) and gifts (1.0 %). Those offered for consumption in ceremonies, 44 % were in funerals and 22 % in weddings. Chickens are more commonly utilised in social functions than other livestock. Chicken play an important role for households in fulfilling their social responsibility to the community. Losses from diseases, predation and theft accounted for 43.9 % of flock offtake. Birds provided for breeding were on average 20 weeks old while those offered to ceremonies were 29 weeks old. Based on their previous weeks' live weights, chickens lost through diseases (835 g) and predation (921 g) had significantly ( $p < 0.05$ ) lower live weights than those utilised ( $> 1100$  g).

Annualised values were MK958 (1US\$ = MK85.00) for home consumption, MK636 for ceremonies, MK403 for sales, MK66 for breeding and MK43 for gifts per household flock (average flock size of 12.9, SD 8.4). Per each flock, losses due to diseases and predation were valued at MK567 and MK420, respectively.

The study has determined and valued household and social functions of local chickens in rural communities. Value of losses due to diseases and predation is also of great importance, signalling health and management constraints. These values provide information for the design of breeding goals and justifying appropriate community based breeding and management programs to improve village chicken production.

**Keywords:** Community based production system, economic and social functions, flock migration, values of local chicken

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## Characterise the Promising Economic Indigenous Chicken in Cambodia

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Animal genetic diversity may be carrying unidentified genes which could be critical for increasing production or special adaptation. In spite of their numbers and potential, chicken are rarely recognised primary consideration in economic activities. In Cambodia, even the increase of chicken population is found, its share in total meat consumption is reduced from 29 % to 13 % whereas per capita ownership were dropped from 1.8 to 0.8 in last two decade. This paper is to describe the appearance performance of some chicken breed candidates in Cambodia and attract the need for further investigation. To identify the characteristic of indigenous chicken breed, 150 householders were sampled from various areas. Seven candidate of breeds were recorded. Moanprey (Red jungle fowl), represented 2 % of total indigenous chicken, can be distinguished from Sampov (Local bantam), which accounted for 55 % of sample, by the largish white rump patch of the male and slate-grey legs of both sexes and relatively small in mature size. Kandong (Slow feather), Skoey (Bicolour), Kragnas (Frizzle), Samley (Dwarf) represented 10 %, 7 %, 5 % and 5 % respectively in total sample and are the candidate for further investigation in heat stress tolerance, disease resistance and meat quality. Moanchol (Fighting cock), about 16 %, has a very high statue in the hobbies of society. Mature body size range from 3–3.5 kg of Sampov, similarly to Moanprey, Kandong, Skoey, Kragnas and Moanchol to 0.5–0.8 kg of Samley. Egg laying are 5–15 egg with mounting period of 1–3 week. The share of specialised broiler and layer breed is increased from 1 % to 15 % of total chicken population in last two decade. The most rational and sustainable way to conserve chicken genetic resources is to ensure that indigenous breeds remain functional parts of production systems, conservation through use. This is possible only if economically important attributes of indigenous breeds are identified, studied and incorporated in breed improvement programmes. Identification of unique attributes should also increase interest in these genetic resources.

**Keywords:** Genetic diversity, indigenous chicken, promising economic breed

## **Effect of Extrusion and Microwave Techniques on Nutrient Quality of Soybean in Piglet Diets**

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This study was conducted in Thailand to investigate the effect of microwave and extrusion techniques on nutrient quality of soybean. Soybeans were treated by microwave at 55 and 85 °C. Extrusion was also carried out at 110 °C. There were no treatment differences on dry matter, ash, crude protein, ether extract, crude fibre and nitrogen free extract. Microwave heat treatment did not affect the fatty acid composition. However, the microwave heat treatment activated the peroxidase, which resulted in an increase in lipid splitting enzymes as shown by the higher content of malondialdehyde compared to the extrusion treatment. Increasing the temperature from 55 to 85 °C by microwave and using 110 °C by extruder technique resulted in decreased trypsin inhibitor content (24.12, 19.61 and 9.54 TIU mg<sup>-1</sup> respectively). The results of feeding trial with 24 piglets at the University farm indicated that the temperatures at 55 and 85 °C of microwave treatment were not high enough to destroy all the trypsin inhibitor in soybean. The production performance based on average daily gain and feed conversion ratio of the piglets fed with microwave treated soybean at 55 and 85 °C were less ( $p < 0.01$ ) than those of the piglets fed extruder soybean treated at 110 °C and soybean meal supplemented with soybean oil (0.20, 0.23, 0.40, 0.43 kg d<sup>-1</sup> and 3.68, 3.26, 2.01 and 1.73 respectively). As it can be seen out of the results microwave technique can be used as a source of energy to destroy trypsin inhibitor in soybean but the temperature should be increased to that of the extrusion technique.

**Keywords:** Extrusion, microwave, oil quality, performance, piglet, production, trypsin inhibitor

## Phenotypic and Genetic Correlation Estimates among Systematic Factors, Productive Traits and Fertility Traits

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Phenotypic and genetic correlations show relationships between phenotype and genotype traits. These parameters are important especially in multi-trait selection and improvement programs because they are used in the calculation of selection responses. However, phenotypic and genotypic correlations differ among populations due to genetic and environment differences. The objective of this study was to estimate the phenotypic and genetic correlation among systematic factors, production traits, and fertility traits of Northern Thai dairy cattle population. Reproduction traits, milk yield, and milk contents were measured using 2,764, 1,673 and 391 heifers respectively. The number of sires ranged from 85–570, resulting in fairly small progeny group sizes of 4.2–4.6 in average. Genetic correlations were based on the animal model, employing restricted maximum likelihood calculation. The fixed effects were herd-year, season, and % of Holstein-Friesian (HF). The co-variable was days in milk.

The results revealed that phenotypic correlations between % HF and milk contents ranged between  $-0.076$  and  $0.030$ , and that between % white colour and milk contents between  $-0.122$  and  $0.049$ . Phenotypic correlations between age at first calving and milk contents ranged between  $-0.048$  and  $0.043$ , while that between age at second calving and milk contents between  $-0.142$  and  $0.079$ . The phenotypic and genetic correlations between milk contents ranged between  $-0.091$  and  $0.286$  and  $0.008$  and  $0.283$  respectively. Meanwhile, phenotypic and genetic correlations between the different fertility traits ranged between  $0.054$  and  $0.858$  and  $0.007$  and  $0.613$  respectively. The results suggest that genetic correlation between fertility and milk yield is neutral, while that with the different reproduction traits: service period, insemination index and calving interval is clearly positive ( $r = 0.3$ – $0.6$ ). This indicates an autocorrelation of the same genetic phenomenon.

**Keywords:** Dairy Cattle, Genetic correlation, phenotypic correlation

## The Effects of Calving Season and Calving Years on Productive and Reproductive Traits of Dairy Cattle Population in Thailand

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In dairy farming, environmental differences influence performance significantly especially between the temperate and tropical countries. The question of a possible genotype-environment interaction between these two completely different production environments thus arises. In the tropics, there are more differences in dairy cattle performance because the climatic variability between seasons and years is more. In Thailand, a tropical country with three different seasons, climatic and weather differences between seasons and years are immense. This might affect productive and reproductive traits of cows that calve during the different seasons and years. The objective of this study was to determine the effect of calving season and calving years on productive and reproductive traits.

The results revealed no significant effects of calving season and calving years on milk yield at 100 days, milk yield at 305 days, % protein, % fat, % lactose, total solid and solid not fat. However, a clear interaction between calving season and calving years on milk yield at 100 days and milk yield at 305 days was observed. During the rainy season, days open and days of heat return were higher ( $p < 0.05$ ) than in the winter and summer season. During winter, service per conception was lower ( $p < 0.05$ ) than in the rainy and summer season. Meanwhile, in summer, the calving interval was higher ( $p < 0.05$ ) than in the rainy and winter season. For the calving years, no effects on days open, gestation length, days of heat return after calving and calving interval could be observed. However calving years affected the service per conception.

**Keywords:** Environmental effect, productive traits, reproductive traits



## Effect of Modified Atmosphere on Shelf Life of Fresh Poultry Meat Dipping in Propyl Gallate Combined with Phosphoric Acid

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Propyl gallate dips of poultry meat are commonly used to prevent rancidity. In the practice, Propyl gallate is always used in combination with acid. This might enhance the antimicrobial effect. Recent studies revealed that propyl gallate applied at a dose of 40 g/kg in combination with phosphoric acid (30 g/kg) was effective to control the poultry meat spoilage at 4 °C for 21 days. Also, a new packaging technology called modified atmosphere packaging (MAP) has been introduced in Thailand as an alternative for extending shelf life of poultry meat. This study investigated the effect of MAP on Shelf life of fresh poultry meat dipping in Propyl Gallate combined with phosphoric acid

Poultry thighs were dipped in propyl gallate and phosphoric acid solutions for 10 min and then packed in a modified atmosphere of CO<sub>2</sub> concentration 0, 20, 40, 60 and 80 %. There after, samples were stored at 4 °C for 0, 14, 28, 42, 56 and 72 days to detect the growth of total colony count, *E. coli*, *Staphylococcus aureus* and *Salmonella*.

The results showed a microorganism (yeast, mold and bacteria) count of  $> 3.0 \times 10^7$  colony forming units (cfu)/g after a 42 days storage period. *Salmonella* were not detectable for every storage time tested. *E. coli* and *Staphylococcus aureus* counts were less than 1100 cfu/g for every storage period. The results indicate that a CO<sub>2</sub> concentration of 40–60 % is essential for prolonging the shelf-life of poultry thigh at 4 °C to 28 days. This concentration was effective in controlling *Salmonella*, *E. coli* and *Staphylococcus aureus* growth.

**Keywords:** Modified atmosphere packaging, phosphoric acid, poultry, propyl gallate, shelf life

## Facilitation of Community Action-learning Processes for Harnessing Trypanotolerance in Traditional Cattle Herds in the Ghibe Valley, Southwestern Ethiopia

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Livestock, particularly cattle, play crucial roles in providing food security to smallholder farming communities in developing countries like Ethiopia. Trypanosomosis is the single most important disease in large parts of Africa with warm and humid climates, and causes huge losses of livestock and livestock production. In Ethiopia the disease risk covers about 15 % of the total arable land and affects up to 14 million head of cattle, as well as an equivalent number of small ruminants, equines and camels. The most widely used methods of containing cattle trypanosomosis are the use of trypanocidal drugs and pesticides against the vector, the costs of which are considered very high. A more cost-effective and sustainable alternative for the control of trypanosomosis is exploitation of trypanotolerance, as exhibited by some indigenous breeds from disease-endemic areas. Apart from their capacity to survive and produce under trypanosomosis challenge, these animals respond better to trypanocidal drug treatments. Systematic breeding and dissemination of superior trypanotolerant animals within existing herds provides a potential solution that can be implemented at the community level with minimal dependency on external inputs. A one-year on-farm participatory research project is being implemented with the aim of facilitating community action-learning processes for the identification, enhanced breeding and dissemination of such cattle. A total of 1033 heads of cattle from 149 households with at least one adult cattle identified as trypanotolerant by their owners have been continually monitored for parasitaemia and PCV (Packed Red Cell Volume), which, together with clinical signs of ill-health and history of trypanocidal drug treatments, serve as indicators of relative trypanotolerance. A series of village level meetings have been facilitated to introduce the essential breeding concepts and practices, to develop suitable breeding interventions and to report back findings. This paper presents highlights of the community action-learning processes employed for the screening and selective utilisation of trypanotolerant cattle in the village herds. It also identifies the next steps required to develop this initiative into a community-based breeding scheme in the Ghibe valley for aimed at improved harnessing trypanotolerance. The findings have implications for community-based breeding schemes in other developing countries.

**Keywords:** Cattle, community action-learning processes, Ethiopia, Ghibe valley, participatory research, trypanotolerance

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## Molecular Characterisation of the Porcine Lung Cancer Candidate Gene (FUS1)

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FUS1 is a candidate tumor suppressor gene (TSG) organised in a 370-kb region, which contains a set of 19 genes. The human FUS1 genomic sequence spans 3.3 kb containing three exons. Overexpression of the FUS1 gene leads to G1 arrest and growth inhibition of lung cancer cells, and reduces also the spread of lung cancer in mice. Thus, this gene may provide a novel way of selectively destroying cancer cells in mammals. The human and the murine FUS1 genes were assigned to chromosome HSA3p21.3 and MMU9F1, respectively. Our sequence characterisation of the porcine PAC clone TAIGP714O11196 revealed the identical gene cluster for pigs and humans with respect to genes FUS1, FUS2 and the genes of the HYAL cluster (HYAL1, HYAL2, and HYAL3). We have recently mapped the porcine FUS1 gene to SSC13q21-q22 and reported its localisation upstream of the porcine hyaluronidase gene cluster. Sequencing of the porcine PAC clone led so far to the determination of 3110 bp of genomic FUS1 sequence. This partial sequence contains exons 2 and 3 sharing about 86 % and 84 % homology with the human cDNA sequence, respectively. We also managed to characterise the 3'-end completely by applying RACE-PCR and cDNA extracted from porcine testis. We further intend to accomplish the complete porcine FUS1 sequence by primer walking to close existing gaps on the clone. In addition, cDNA sequences will be generated to characterise the gene structure and expression analysis will be performed using several different porcine tissues. Finally, screening for polymorphisms in the gene will be done using European, Chinese and Thai native pigs. Possible mutations in the porcine FUS1 gene could make it an attractive candidate for further functional tumor suppressor gene studies and the pig a model animal in cancer research and therapy.

**Keywords:** FUS1, pig, porcine lung cancer candidate gene

## Type Differences in Rendille Camels of Northern Kenya with Regard to Drought Tolerance

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The study aimed at describing the Rendille camel breed in Northern Kenya by differentiating scientifically its locally distinguished four performance types, namely Dabakh, Aithimaso, Godan and Coitte (sorted according to their milk performance level from high to low). The local assessment suggests that there are no differences in body dimensions, but in the ability to maintain a good body condition during dry season, the periods of fodder and water shortage. Thus, focus was on characteristics of body size, body weight and body condition, measuring 461 camels within a 3-month study period. Body weight was estimated based on thoracic girth, height at the withers and rump length. Body condition was determined applying ‘butcher’s grasps’, measuring hump size and assigning a body condition score from 1 (poor) to 8 (excellent), based on visual assessment. Body condition was expected to differ most at the end of the long dry season, hence the time this study was conducted. Analyses of variance and chi-square tests were performed in order to test differences between the types. The assumption of no significant differences between types in terms of height at the withers was rejected ( $p < 0.05$ ) except the Aithimaso type which was smaller ( $p < 0.05$ ) in the withers compared to the other three types. Breast width of Godan, another measure of body dimension, was widest and significantly different ( $p < 0.05$ ) to Aithimaso and Coitte. Hump circumference of Dabakh was significantly smaller ( $p < 0.05$ ) than all other types. Body condition scoring revealed further differences between types ( $p < 0.05$ ), supporting the criterion “drought tolerance” used by the pastoralists in distinguishing their camel types. Thus, even within one breed the ability to maintain a stable body condition is not uniform, but it differs between the different performance types. Body reserves play a decisive role in reproduction and milk production, and, in case of severe drought, even for survival under harsh conditions. It would be useful to include the trait body condition stability as an indicator for drought tolerance in breed characterisation, as it is an important adaptation trait for livestock breeds kept in resource-poor husbandry systems, for which seasonal fodder shortage is an inherent feature.

**Keywords:** Body condition, drought tolerance, Kenya, rendille camel, type differences

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## Going Backwards? Moving Forward? — Nguni Cattle in Communal KwaZulu-Natal

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Nguni cattle have evolved in South Africa in precolonial times, as small, early maturing, docile and disease resistant multi purpose cattle, which attained a high cultural importance, particularly among the Zulu. Early colonial farmers and scientists rejected them as poor beasts and advocated their replacement with cattle with at least some European blood. During the period of apartheid, with labour tenants and homelands, agricultural services were also active in discrediting indigenous livestock breeds, and slowly communal farmers accepted that large framed, so-called commercial animals would be better, and that good animal husbandry includes supplementary feed, regular dipping for tick control and other veterinary interventions. With a reduction of state subsidies after 1994 these measures became less and less economically viable for communal farmers. Four decades ago, it was feared that the Nguni breed would become extinct. Some scientists and commercial farmers became interested in Nguni as hardy, low input animals, acquired Nguni cattle and formed a breed society, with now some 20000 registered breeding animals. A recent book on variability and indigenous classification of Ngunis became a best seller, yet all this had little impact on communal cattle farmers.

During a recent study for two development projects in KwaZulu Natal cattle keepers claimed ignorance of the advantages of Nguni cattle, which according to them, was something for white farmers, although reportedly a large number of Nguni cattle of varying purity is being kept in communal areas. Already during the study a booklet, showing various South African livestock breeds, created interest in Nguni cattle among communal farmers. As a first step both projects organised farmers' visits to stud farms and research stations that keep Nguni cattle. Discussions with farmers are under way of how promote Nguni cattle breeding in the project areas. Community bull keeping may be an option in some areas, but is difficult in others, because of cattle theft, particularly of new "exotic" animals. Given the high technical standards of South African services, even AI and synchronising cows, in order to produce Nguni bulls "on the veld" should not be discharged, and is in fact being tried.

**Keywords:** Adaptation, promotion of indigenous breed, South Africa

## **Community-based Management of Small Ruminant Genetic Resources in Benin — An Approach to Develop a Conceptual Framework**

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In Benin, small ruminants are traditionally kept in smallholdings in almost all rural households. They play an important role in the livelihoods of poor people, particularly women. The need for sustainable livestock improvement strategies to increase the livelihoods of these poor people is evident. The existing farm animal genetic resources are still poorly characterised and most improvement programmes have resorted to crossbreeding or direct substitution. Breeding programmes, that take into account the ecological, socio-economic conditions, objectives and preferences of the farmers, are lacking. The Convention on Biodiversity states that genetic resources should be conserved in the surroundings where they have developed their distinct properties and that knowledge, innovations and practices of local communities should be used for sustainable use of biological diversity. The framework proposed in this paper aims at ensuring the full and active participation of farmers in the sustainable use of the existing small ruminant genetic resources. Spatial differentiation by agro-ecological and socio-economic conditions will be quantified due to resource allocation and production objectives, including breed/traits preferences. An assessment of the biophysical and socio-economic circumstances of farmers using PRA methods and the integration of data within a GIS environment is expected to present a more realistic picture of the extent of interactions among key variables. Obtaining the perspectives of different farmers in agro-ecological zones ranging from humid to semi-arid zones through participatory research, analysing the details of their management practices and local knowledge and characterising their animals is expected to guide recommendation domains for community-based management strategies and actions. Implementation will be facilitated through regular community meetings and interactive learning sessions using the “expert farmer” approach. The expected outcome of the action research approach is to develop and implement a sustainable breeding programme that reflects the objectives of farmers and conserves the local animal genetic resources.

**Keywords:** Expert farmer, animal genetic resources, Benin, breeding programmes, community-based management

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## **Determination of Marginal Utility of Central Characteristics for Pig Breeding in Ukraine**

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The analysis of relevant breeding targets in pig fattening is of high relevance to produce products which fulfil the expectations of consumers and the processing industry and to support agricultural enterprises to place their production strategy as close as possible at the market. Analyses showed that there exist big deficits in Ukraine.

Estimated breeding values (natural breeding values) of the single characteristics have to be assessed with their economic weight, since the importance of breeding characteristics in the breeding target should be basically be attached according to their economic relevance in the production stage respectively in the downstream outlet market.

The main objective of the presented study is the determination of economic weights of single performance characteristics under consideration of the specific Ukrainian production and market conditions. The marginal utility was used as economic weight of the performance characteristics.

Farm interviews (42 farms in Ukraine), single measurements and intensive interviews of key persons in Ukraine were conducted in order to establish the data base for the analyses. The results of the analyses were compared with according analyses of the State/Bavaria.

The analyses show that food utilisation is the main criteria with an value of -15.2 €. The economic weight for the daily gains in life weight is deducted from a reduction of the fattening period and amounts 0,01 € for a daily gain of 1 g. The number of living born piglets and number of reared piglets can be used for the breeding characteristic fertility. Here the analyses showed that both criteria are given a much higher weight in Bavaria with an economic weight of 4.50 € both compared to Ukraine (1.16 € respectively 1.70 €). The economic weight for the thickness of backside bacon is 1.09 € in Ukraine (share of fatless meat in Bavaria 1.00 € for the mother race and 2.25 € for the father race).

The calculated economic weights provide important indications for the improvement of breeding to increase economic efficiency and so the competitiveness of pig production in Ukraine.

**Keywords:** Marginal utility, pig breeding, Ukraine

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## **Critical Factors for the Success of Community Breeding Programmes for Smallholder Dairying in the Tropics**

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To satisfy the increasing demand for milk and milk products in tropical countries sustainable measures have to be taken to improve the local milk production. Sustainable improvement could be attained by the association of farmers to set up a communal genetic improvement programme which also implies awareness raising and management improvement. Such a breeding programme should be simple, practical and at low costs. Therefore, a virtual nucleus rather than a station nucleus should be considered. The objective of this study is to identify and quantify the impact of different factors like management, recording quality and breeding scheme on the efficiency of a breeding programme. The efficiency of a breeding programme depends on the one hand on the genetic gain attained per year which is a function of selection intensity, accuracy, genetic variation, and generation interval taking into account inbreeding. On the other hand there are the costs. The following calculations are based on a population of 1000 cows with natural mating (mating relation 1:40; useful life of bulls: 3 years; pre-selection factor: 2). Management is represented in survival rate of calves and calving interval. Given good management with a survival rate of 80 % and a calving interval of 18 months, 83 bull dams are required for the provision of breeding bulls while under bad management conditions (survival rate 50 %, calving interval of 30 months) 222 are needed. Theoretically, accuracy of selection is calculated based on the amount of information considering genetic relationships and the population parameters. This accuracy assumes an optimal breeding structure, pedigree recording and accurate recording of environmental effects. Breeding efforts may be nullified if environmental effects cannot be corrected for. The breeding scheme suggested for tropical cattle breeding is a young sire programme where the generation interval (about 4 years) is substantially lower than in a progeny testing programme (>10 years). Additionally, it is much simpler and cheaper to organise. Thus, it is evident that breeding efforts under unfavourable conditions only promise good success if the farmers understand the breeding procedures and co-operate with regard to management and recording.

**Keywords:** Breeding, communal, dairy, smallholder, tropics

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## Strategies for the Sustainable Utilisation of Indigenous Breeds in Central and Eastern European Countries (CEECs)

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The enlargement of the EU market causes increased competition in Central and East European Countries. Farmers in the CEECs adapt to these changing economic conditions by specialising and intensifying their production. Small farms where indigenous breeds are mainly kept, are likely to be pushed out of the market. These processes lead to increased rural poverty and to a loss of agricultural biological diversity. The maintenance of agricultural biological diversity delivers positive external effects. As the market fails to reward these positive external effects there is an urgent need to find adequate means to internalise these effects. Possible means to identify the adequate amount of subsidies to be paid are economic valuation methods to assign a monetary value to non-market values. Other reasons for preservation of traditional breeds include the uncertainty of future conditions for food production and therefore the responsibility to preserve options for the next generations. The study presents approaches for in-vivo preservation for indigenous breeds in CEECs. In considerations of the goal of sustainable development emphasis is placed on approaches to preserve the breeds through the utilisation of their specific characteristics. Referring to policies developed by the FAO, following steps were identified.: **i)** identification of indigenous breeds in a country, **ii)** evaluation of the breed with regard to their products and other benefits they provide to the society, **iii)** classification of the breeds according their benefits derived from economic, ecological, cultural and scientific values. **iv)** development of suitable preservation approaches related to the identified values. Requirements for the implementation of preservation approaches are outlined. These include the adequate institutional setting which should incorporate means to institutionalise public participation. This market based preservation approach which is reflected by two case studies does not only take into account products commonly associated with a breed but recommends the use of other characteristics, providing specific services as for tourism or the environment. The support of marketing of specific products and services through the use of indigenous breeds is seen as an chance to prevent their extinction, to build institutions and to assist the development of the rural economy.

**Keywords:** Agricultural biological diversity, economic valuation, environmental services, institutional environment, niche products, non-market value

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## High Genetic Diversity Indices of two West / Central African Cattle Breeds — Hope for More Future Improvement Options?

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The Red Bororo and White Fulani are the main cattle genetic resources in the West/Central African region and are the most important in terms of number and economic value. Genetic diversity indices in 108 Red Bororo and 102 White Fulani animals from Cameroon and Nigeria were evaluated using genotypes of 16 microsatellite and seven protein markers. Mean (MNA) and effective (MNE) number of alleles and expected (Hexp) heterozygosity values according to marker type were high. MNA and MNE at microsatellite loci ranged respectively from 5 to 14 and 2.202 to 6.378 and at protein loci from 2 to 6 and 1.566 to 4.626. The range for Hexp was from 0.549 to 0.848 at microsatellite loci and 0.364 to 0.788 at protein loci. These values are higher than observed for highly specialised European breeds and directly opens the way to positive exploitation in improvement breeding. During the last 50 years in Europe and North America, strong selection pressure through intensive breeding programs led to highly specialised breeds and with it lost of genetic diversity. There currently exist no effective selection programs for the zebu breeds of West/Central Africa. Considering that about 90 % of the Red Bororo and White Fulani herds are owned and managed by Fulani and Hausa pastoralists/agro-pastoralists, their improvement programs must give consideration to this, and also maintain diversity for future exploitation.

An overall significant ( $p < 0.001$ ) deficit of heterozygotes due to inbreeding within individuals ( $F_{is}$ ) was 6.4 %.  $F_{it}$  (global deficit of heterozygotes) was low (7 %) but highly significant ( $p < 0.001$ ). The two breeds were very lowly but significantly differentiated ( $F_{st} = 0.6\%$ ,  $p < 0.001$ ). A high level of gene flow ( $N_{em} = 5.370$ ) was detected between the breeds. Their history of origin and the high level of genetic exchanges between them could cause the very low level of differentiation. Practical and effective pastoral management practices to curb continued genetic exchanges and to maintain diversity would be to geographically demarcate the different breed groups. Finally, improvement schemes for the breeds must also take into account future unknown traits of economic importance by maintaining within the populations all the currently observed alleles.

**Keywords:** African cattle, improvement options, genetic diversity, management practices

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## Evaluation of Small-holder's Breeding Strategies in Production Systems of Kenya and Ethiopia

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Food security and a balanced diet with animal products are not guaranteed. The demand for milk and meat from livestock in Sub-Saharan Africa has almost doubled over the past two decades. One possibility to overcome this gap between demand and supply would be the introduction of an adapted cattle breed with higher production level. Infrastructural and environmental constraints as well as non-market functions of livestock influence the existing breeding structures. The objective of this study is to evaluate the breeding practices of cattle keepers in pastoral, agro-pastoral and crop-livestock systems of selected sites in Kenya and Ethiopia. The knowledge of this basis will offer the possibility to develop an adapted and therefore sustainable breeding program. Local Zebu is the most commonly used breed in the low-input systems of the study sites with high prevalence of several cattle diseases (e.g. Trypanosomosis). This study indicates that the selection of the specific breed is mainly due to its adaptability to harsh environmental conditions and disease challenge, and difficult access to other breeds. Although a difference in disease tolerance and production traits is observed, controlled mating is rarely used. On the contrary, communal grazing is the most frequently used feeding system resulting in non controlled mating. Since farmers mainly lack the knowledge about inbreeding and its consequences, no measurements are taken for prevention. However, the farmers have a clear idea about traits of breeding bulls, and a non-monetary exchange system for favourite bulls exists. AI service for upgrading the local breed is rarely used due to infrastructural and information constraints. Therefore willingness to use AI depends on the education of the farmers and their contact with the technique. Nonetheless, the actual use is restricted by the accessibility of the service and the offer of adequate semen. Locally adapted and well organised breeding structures offer possibilities for sustainable improvement in production traits and disease resistance of cattle. Therefore, the development of breeding programs with special regard to the environmental conditions offer an opportunity for the improvement of livelihood of small-holder farmers through genetic improvement of their production animals.

**Keywords:** Breeding program, farmer preference traits, pastoralists, production system, small-holders, Sub-Saharan Africa

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## The Impact of Soil Quality on Maize Yield in Ghana

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The Northern region of Ghana is the largest administrative region in Ghana. It occupies over 40% of mainland Ghana and has a population of about 1.8 million. About 80% of the people depend on farming for their livelihood, with maize as the most important cultivated food crop. The Northern region of Ghana was once the leading producer of maize in the whole of Ghana, but maize yields have consistently declined in the last few years. This phenomenon constitutes a threat to food security and calls for efforts to explain the downward trend and make recommendations for improvement. The objectives of this study were to evaluate the soils of an area in Northern Ghana for maize on the one hand, and identify factors affecting maize yield on the other. A novel technique that combines soil survey with socioeconomic analyses was adopted in the study. Soil samples were collected within different land-cover types and analysed in the laboratory for chemical and physical properties. A soil quality index was generated for each sampling locations using fuzzy set technique, whereas spatial interpolation of soil quality was carried out by kriging. A structured questionnaire was administered to 237 households in 20 villages to elicit information on factors affecting crop yield. Relationships between maize yield and variables presumed to influence yield were determined using bivariate and linear multiple regressions. The results indicated that soil quality and fertiliser use are the most important factors affecting maize yield. Soil organic C, ECEC and clay were identified as the major soil-related constraints to yield. Other less important variables are related to demography and commercial factors. It is recommended that emphasis should be placed on soil management techniques that conserve soil organic matter and enhance the nutrient and water holding capacity of the soils. Policies that would enhance commercialisation agriculture are also required in Northern Ghana.

**Keywords:** Food security, fuzzy set, kriging, maize yield, soil organic C, soil quality

## The Impact of Different Land Use Systems on Soil Quality of Alfisols of Western Ethiopia

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The success of soil management to maintain soil quality depends on an understanding of how soils respond to agricultural use and practices over times. Currently, large proportions of land in Ethiopia are rendered unproductive. The important soil quality indicators of Alfisols were investigated in 2001 in western Ethiopia under different land use systems to provide base line data for future research and development. The different land systems were the cultivated land, abandoned land, and the virgin land. One soil profile was opened in each system for field descriptions and laboratory studies. The soil physical properties such as structure, bulk density, total porosity and soil water characteristics showed notable variations due to different land use systems. The highest bulk density ( $1.57 \text{ Mg m}^{-3}$ ) was recorded at abandoned land against ( $1.16 \text{ Mg m}^{-3}$ ) in virgin land. Moreover, most of the soil chemical properties were affected. For instance, soil pH ( $\text{H}_2\text{O}$ ) was 5.23 in cultivated land as compared to 6.23 in virgin land. The lowest organic carbon and total nitrogen (1.24 and 0.08 %) were observed in abandoned land whereas the highest (5.90 and 0.33 %) was recorded in the virgin land, respectively. Similarly, the different forms of P were influenced due to different land use systems. The available P was found to be highest, 25.52 and 43.05  $\text{mg kg}^{-1}$  in Olsen, and Bray-II extraction methods, respectively, in abandoned land as compared to 1.90 and 4.78  $\text{mg kg}^{-1}$  in virgin land, because the abandoned land had received P fertiliser for the past three decades. The highest CEC ( $36.0 \text{ cmol}(+)\text{kg}^{-1}$ ) was observed in virgin land whilst the lowest was ( $11.0 \text{ cmol}(+)\text{kg}^{-1}$ ) in abandoned land. The essential micronutrients were also influenced due to different land use systems except for Mo which was trace in all land use systems. In general, continuous use of land for crop production without appropriate soil management has degraded most of the important soil physicochemical properties. Therefore, adoption of appropriate soil management and land use planning could replenish the degraded soil properties for sustainable agricultural productivity in the region.

**Keywords:** Abandoned land, alfisols, land use systems, soil properties, virgin land

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## Soil Fertility Management of Homegardens in Central Sulawesi, Indonesia

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The maintenance of soil fertility is one of the prerequisites of sustainable agricultural systems. Tropical homegardens are generally regarded a sustainable agricultural production system, particularly due to the sustainable soil fertility management by the gardeners. They are said to apply mostly endogenous fertilisers to maintain soil fertility. The multilayered vegetation structure of homegardens is often stated to protect the soil from erosion. However, there is little quantitative data to support these statements. This study aimed to assess soil fertility in homegardens as well as the influence of certain management practices on it over a time period of two years (in 2001 and 2003).

In 30 homegardens randomly selected from three villages adjacent to the Lore Lindu National Park in Central Sulawesi, soil samples were taken in different management zones. Besides pH-value, also bulk density, total C and N as well as plant available P and K were analysed. For assessment of soil erosion, soil samples were taken for analysis of Caesium 137 in three selected homegardens. Information about soil fertility management was gathered in individual in-depth interviews with gardeners, including questions on fertiliser use, frequencies of fertiliser application, methods and frequency of soil preparation, among others.

Results showed that soil fertility in homegardens was dynamic. Both increase and decrease of different characteristics were found. Particular management practices, such as fertilising with ash, were observed to increase pH as well as available P. Although existing, some of the endogenous fertiliser resources were not usually applied (e.g. pig manure) due to lack of knowledge of the gardeners. Specific management zones of the gardens, such as the vegetable area, suffered more from erosion than others, for example, the cacao or fruit tree area, where thick litter or herbage layers were typical. In addition, soil of the vegetable area often showed a higher bulk density, but a lower content of C, N and available P than soil of the other management zones.

In conclusion, soil fertility management in homegardens is patchy and not sustainable per se. Special management practices may need to be improved.

**Keywords:** Central Sulawesi, homegardens, soil fertility management

## **Viability of Mechanized Chop-and-mulch as a Soil Improving Alternative to Manual Slash-and-burn Land Preparation**

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As alternative to slash-and-burn land preparation there are a number of technologies offered at present. Most of these technologies, however, imply essential changes of the customary cropping systems including often even the replacement of the traditional crop species. As a result the slash-and-burn practice can be reduced by introducing forms of permanent or semi-permanent land uses, such as employing perennial crops or tree species to substitute annual crops and hereby reduce the number of fallow periods. However, there is a way to remove the fire from the system entirely, whilst maintaining traditional cropping habits and fallow periods. We present an alternative to slash-and-burn, which does not entail any change of the farmer's choice of crops nor their planting arrangement nor their planting time. Instead of limiting, the technology rather permits greater liberty of choice of these factors. This is done by only replacing the fire as a tool of land-clearing. A tractor driven bush chopper cuts and chops the fallow vegetation in one go and leaves the chips on the ground to form an easily decomposable mulch layer into which any crop can be planted immediately afterwards, providing some mineral fertiliser to overcome initial nutrient immobility. Since this new technology, which we call chop-and-mulch, implies mechanisation and thus a considerable investment at some point, it is of great interest to learn more about its viability to the farmer. Apart from the fact that return on land and labour prove to be higher as compared to slash-and-burn, there are a number of other advantages, such as free choice of planting date due to uncoupling of the dry season that is necessary for the burning and increased rural labour demand due to greater yield-connected activities. The greatest advantage of chop-and-mulch in terms of adoption potential, however, lies in its reversibility, i.e. the fact that the new system can be abandoned at any time the farmer decides. Not being necessarily locked to the technology for too long a time period is probably the biggest asset in comparison to some other technologies that are being offered to avoid slash-and-burn.

**Keywords:** Brazil, bush-fallow, eastern Amazon region, mechanisation, mulch, secondary vegetation, shifting cultivation

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## Integration of Organic and Inorganic Fertilisers — Effect on Vegetable Productivity

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The Ethiopian highlands are characterised by high human and livestock population pressure, land degradation as a result of soil erosion, soil fertility decline and organic matter depletion, low agricultural productivity and persistent poverty. In most of the farming systems, there is low external inputs that crop and livestock production depends mainly on the soil nutrient stock. A field experiment was thus launched at Debre Zeit on Andosols (1999–2001) to evaluate the effects of Farm Yard Manure (FYM) and inorganic fertilisers application on the productivity of horticultural crops. Two selected rates of FYM (2 and 6 Mg ha<sup>-1</sup> on dry weight bases), were combined with three rates of Nitrogen (N) and Phosphorus (P) fertilisers (0,0), (61, 31) and (92,46) kg ha<sup>-1</sup> to make six treatments. A randomised complete block design with three replications was employed. Four crops (Shallot, tomato, cabbage and potato respectively) were planted in a rotation on permanent plots. The treatments resulted in a significant effect on both biomass and economic yields of the crops, but shallot. Supplementing the recommended inorganic fertilisers by only 2 Mg ha<sup>-1</sup> FYM resulted in a significant yield increase over the recommended rates. Also, it was found out that reducing the recommended fertilisers by one third did not significantly reduce yield, if supplemented by 2 Mg ha<sup>-1</sup> FYM. This does not only reduce the production cost due to reduced fertiliser use but also improves the soil quality leading to sustainability.

**Keywords:** Farmyard manure, inorganic fertiliser, marketable yield, organic fertilisers and relative yield index

## Assessment of the Natural Abundance Method in Estimating Dinitrogen Fixation of *Gliricidia sepium* (JACQ) Walp in Cacao Agroforestry System in Central Sulawesi Indonesia

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Nitrogen fixing trees play a major role in improving soil N fertility. However there are only a few studies available in evaluating their capacity to fix N<sub>2</sub> especially under field condition due to methodological difficulties. Research was conducted at two sites (Kaduwaa and Makmur) in 7–8 years old cacao agroforestry system in Central Sulawesi Indonesia to evaluate whether <sup>15</sup>N natural abundance method could be used to estimate N<sub>2</sub> fixation by *Gliricidia sepium* (Jacq.) Walp. by i) measuring variability of <sup>15</sup>N with soil depth and time, ii) measuring biological nitrogen fixation with different reference plants as well as at different times of the season.

The  $\delta^{15}\text{N}$  value of total soil N ranges from 6.2 to 7.9 ‰ and from 7.4 to 8.8 ‰ in Kaduwaa and Makmur, respectively. The  $\delta^{15}\text{N}$  value of total soil N at both sites shows little variation with soil depths (30–150 cm) except that the top soil (0–10 cm) is less enriched suggesting dilution by atmospheric N. Foliar  $\delta^{15}\text{N}$  of fixing and reference plants depends upon plant species, time of sampling and site. The means and standard errors of foliar  $\delta^{15}\text{N}$  for the five times of sampling are  $3.5 \pm 0.23$ ,  $5.3 \pm 0.25$  and  $5.7 \pm 0.37$  ‰ for *Gliricidia sepium*, *Theobroma cacao* and *Coffea arabica* in Kaduwaa and  $2.3 \pm 0.23$ ,  $3.5 \pm 0.21$  and  $3.7 \pm 0.27$  ‰ for *Gliricidia sepium*, *Theobroma cacao* and *Sida retusa* in Makmur, respectively. In Kaduwaa the proportion of nitrogen derived from atmosphere (% N<sub>dfa</sub>) ranges over time between 11–52 % ( $30.9 \pm 4.4$ ) and 10–58 % ( $33.8 \pm 3.9$  %) with cacao and coffee as reference plants, respectively. In Makmur the estimate ranges over time between 14–50 % ( $31.8 \pm 9.5$ ) and 26–58 % ( $36.9 \pm 7.3$ ) with cacao and sida as reference plants, respectively. Reference plants thus did not affect the estimate of % N<sub>dfa</sub> of *Gliricidia* at all times of sampling. Total N of leaf litterfall and pruning of *Gliricidia* over 48 weeks is between 91–101 kg N ha<sup>-1</sup>. Assuming % N<sub>dfa</sub> of *Gliricidia* is between 30.9–36.9 %, it means that *Gliricidia* could contribute 28–37 kg N ha<sup>-1</sup> or 50–60 % of fertiliser N ha<sup>-1</sup> yr<sup>-1</sup>. As farmers usually apply 60–70 kg Urea-N ha<sup>-1</sup> yr<sup>-1</sup>, they could save the amount of 12–15 € ha<sup>-1</sup> yr<sup>-1</sup>.

**Keywords:** *Coffea arabica*, fertiliser N, *Sida retusa*, *Theobroma cacao*

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## Socio-economic Analysis of Land Use Changes and Soil Conservation in Uganda

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Decreasing agricultural land is a challenge among developing Countries. This pertains also in Uganda where increasing populations reduced land availability per capita. To cope with shortages, farmers resorted to non-sustainable land use practices that are accelerating land degradation. Consequently, living standards of most farming families have declined as characterised by low incomes. This study therefore, analyses the driving forces behind family resource use changes and decision-making in two zones in Uganda with different soil conservation usage levels. Conservation here refers to use of erosion control structures. Intensive soil conservation zone designates where mulching covers 50 % of land and earth bunds used on 40 % of it, below these level constitutes low soil conservation. Farming systems methodology is adopted in this study; covering farm level aspects, family decision-making process and linkages between land degradation or mitigation with property rights. Data were obtained from the survey by administering a standardised questionnaire to 100 randomly selected families in two areas representing intensive and low soil conservation zones. Supplementary data were obtained through key person interviews and field observations. Comparative results of land allocation trends in both zones covering last 20 years indicate that crop and pasture hectarages increased rapidly in the two zones, though with higher increases in soil conservation intensive areas. Contrary forests hectarages decreased in both zones indicating that crop and pasturelands increased at the expense of forestland. Worthy noting however is the increasing size of unusable land, a surrogate for land degradation during the same period. This partly explains the apparent low crop yield reported at most farms. Farmers are adopting various measures to improve and conserve the land albeit, differentially. The impact of this is reflected in levels of farm incomes (Ug.Shs) that are 3 times more in intensive zone as compared to low conservation usage locations. This translates further into differentiated total family incomes exceeding 200 % in intensive zones when compared with that recorded in low conservation intensity areas. These results attest to the potential of soil conservation adoption on improving living standards of farmers and providing sustainable land management options in face of land use changes.

**Keywords:** Farm resources, land degradation, land use, living standard, socio-economics, soil conservation, sustainable land management

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## **Land Resource, the Challenge and Potential for Future Economic Development in the Mountainous Area of Vietnam — The Case of Mai Son District**

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The agricultural production sector contributes mainly to the living standard of the farmers in the mountainous areas of Vietnam as indicated by high dependent level on natural resources especially land resource. The area for agricultural production is limited therefore a small change on this resource in both quantity and quality will lead to potential challenges or opportunities for the sustainable development in the area. The overall objective of this study was to identify the different challenges and potential of future land resource change in the different settlements that will impact on the economic development in the area. In addition to farming and rural systems approaches method, the dynamic linear programming model was used to measure the impact of different change in the land resource on the economic success in farm families.

The increasing advantage of resources for economic development combined with the access to infrastructure and markets indicate that the population densities will increase rapidly in urban and peri-urban centres implying land for agricultural production will become scarcer in these areas in future. While on sloping areas such as middle altitude and high mountainous areas the increasing population will lead to increasing demand on food supply that will put more pressure on land accelerating overuse and misuse with increasing soil erosion and degradation process in this area. The dynamic linear programming models show that declining farm size will be the main challenge for future economic development in the area because this leads to family income reduction ranging between 9 % and 25 % with reduction of 10 % and 30 % of land size over ten years period respectively. Soil conservation programme will increase soil fertility and crop yields, which will generate higher incomes for farms and families in the future averaging more than 30 % per year as compared to the without programme. This indicates a high potential for the future sustainable development on the sloping land areas.

**Keywords:** Future strategy, land resource, mountainous areas, Vietnam

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## The Spatial Distribution of Selected Soil Physical and Chemical Properties of the Surface Layer of the Primary Forest Reserve ‘Reserva Ducke’ Near Manaus, Brazil

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We studied the spatial distribution of selected physical and chemical soil properties of the surface soil layer of the 100 ha primary rainforest reserve “Reserva Ducke” near Manaus, Amazonas, Brazil. We studied particle size distribution, pH, total nitrogen, organic carbon, inorganic phosphorous, exchangeable cations and aluminium of the top 5 cm from 72 quadrates of 1 km<sup>2</sup>. Each sampling area was separated equidistantly across the rainforest reserve.

Sand as dominant particle size (> 60%) prevailed at lower altitudes (< 60 m) and on slopes whereas clay (> 65%) predominated in the middle part of the reserve along the plateau. The pH (H<sub>2</sub>O) ranged from 3.5 to 4.9 and the pH (KCl) from 2.7 to 3.9. Mean organic C was 26.3 g kg<sup>-1</sup>. Lowest concentrations of about 7 g kg<sup>-1</sup> were found at lower altitudes where sandy soils predominated and higher concentrations of about 40 g kg<sup>-1</sup> were found along the plateau. Throughout most parts of the reserve very low inorganic phosphorous concentrations of < 4.5 mg kg<sup>-1</sup> existed. The lowest concentrations were obtained along the plateau. The aluminium (Al<sup>3+</sup>) saturation of the soils was 89% on average. Highest exchangeable Al<sup>3+</sup> concentrations (> 2.0 cmolc kg<sup>-1</sup>) occurred on the plateau.

The spatial distribution of the particle sizes and the soil chemical characteristics coincided with the spatial occurrence of albic Arenosols at lower altitudes and ferralsols at higher altitudes and on the plateau.

The present study demonstrated the importance of topography as major determinant of the soil spatial distribution and physical and chemical characteristics of topsoils across an Amazonian rainforest.

**Keywords:** Amazon rainforest, soil spatial distribution

## Does Integrated Farming Improve Livelihoods of the Farmers? — The Case of Northeast Thailand

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Continuous land degradation endangers household food security in the Northeast of Thailand. To cease land degradation and regain productivity, farmers have organised themselves in groups to come up with alternative agricultural practices. Integrated farming is such an alternative promoted amongst farmers. Advocates of integrated farming argue that this type of farming increases household food sufficiency and incomes, while it decreases migration into cities. The objective of this investigation is to test whether household food sufficiency and incomes are higher for integrated farms than for conventional farms, and if not, what are the conditions for integrated farms to achieve these goals? To answer the research question, a survey was conducted in the Huai Nong Ian catchment in Khon kaen province, Thailand. Since 1997 integrated farming has been promoted among the farmers in this catchment. The catchment was divided into three areas: up-, middle-, and downstream to control for large variation in biophysical factors. For each farming system and for each area respectively, three, two and three farm households were selected; giving a total of sixteen farm households. Household characteristics, farm resources and land use histories were recorded for each farm. Soil physical and chemical properties were analysed from twenty composite samples from rice paddy field. The vegetation diversity and structure were investigated through transect line, size 10 × 80 m. Parametric and non-parametric tests were used to compare differences in means and medians between the farming systems. The results show that integrated farms in areas where water and soil nutrients are limited, attain significantly higher food sufficiency and farm incomes as a result of both a larger number and a higher diversity of crops and animals. Yet, in those areas where water and soil nutrients are not limited, food sufficiency and farm income of integrated farms is not significantly higher than conventional farms. Because integrated farming benefits the farm households especially in areas where soils and water resources are most limited, integrated farming can be an appropriate technology to rehabilitate degraded land. Yet, switching from conventional to integrated farming requires substantial investments while benefits are only received after a few years.

**Keywords:** Food sufficiency, integrated farming, land degradation, Thailand

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## Resource Management in Practice — Community Forestry in Andhra Pradesh under the Joint Forest Management Program

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Scientific forestry with the aim of sustainable supply of products from the natural resource forest was introduced in India more than 100 years ago. The rapid degradation of forest resources under the regime of state control has been a major concern for national and international agencies. As a result, forest policy in India got shift from traditional command and control approach to participatory forest management approach with local fringe communities. It is focused on sharing both responsibilities to protect the forest and benefits from the forest resources. This is popularly known as Joint Forest Management (JFM).

Recently the Centre for Development Research in Bonn (ZEF) conducted a study on “Determinants of Sustainable Management of Forest in Indian State of Andhra Pradesh” in order to identify the crucial factors that determine the effective management of forest resources under the JFM program. An intensive research has been conducted in 55 villages in three districts representing three different ecological conditions to evaluate socio-economic and ecological outcomes of JFM programs.

This paper makes an attempt to assess how effectively the forest management activities have been carried out under the JFM program. The major findings of the study are that the implementation of forest management activities has often not been done on the basis of site conditions and the state of the forest. Mostly a stereotype approach has been adopted while carrying out different silvicultural practices. As a result, most of the examined sites show that potential growth of the forest has been far below expected levels, and applied management systems have been rendered wasteful. This paper presents the main factors that hinder forest development and improvements in the livelihood of local people. It concludes with suggesting new ways to make the established programme more efficient.

**Keywords:** Andhra Pradesh, fire, forest, India, joint forest management, Silviculture

## Soilscapes of the Drâa Basin — Southern Morocco

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The Drâa is situated in the dry zone of the southern part of the High Atlas Mountain in southern Morocco. A large N-S-transect (> 400 km) along an extreme gradient of altitude (3.200–445 m) and aridity (600 > 50 mm rainfall per year) at 6°30' W longitude is taken. From periglacial up to desert landscapes 13 study sites are chosen. Their soil cover was investigated 2001–2003 to detect differences in their potential use and degradation risk. This was in the framework of the project IMPETUS — an integrated approach to the efficient management of scarce water resources in West Africa. So-called soil(land)scapes are build up by several polypeda or pedocomplexes and correspond to the pedochore after the choric idea of soil geography (SCHLICHTING 1970). The different soils of a soilscape result in a soil associations. Different soilscapes are presented here using the World Reference Base for Soil Resources (ISSS-ISRC-FAO 1998).

Calcisol-soilscapes on steep slopes and a transmountain basin of the calcareous High Atlas are rich in carbonates (up to 58 %). The silty and loamy silty texture has high contents of gravel (20–86 %). The soil cover of the Leptosol-Regosol-soilscape in the crystalline Anti-Atlas is generally very thin (5–25 cm soil depth) and incompletely conserved between volcanic outcrops. The Leptosol-Regosol-Calcisol-soilscape of the escarpment relief of sedimentary rocks of the middle Drâa is developed with deep Calcisols and their eroded relict as free-rinsed calcrets of a total eroded escarpment. All these soilscapes on slopes indicate a strong degradation by water erosion.

The Arenosol-Fluvisol-Anthrosol-soilscapes of some Drâa oasis include important arable land. These alluvial deposits suffer rising salinisation with the South up to 16,1 dS/m and are no more used there. The occurrence of a low ground water table less quality, a finer soil texture and probably more salty alluvial deposits of the southern terrace can explain this situation. The drying former lake Iriqui (end of the Drâa river) is characterised by a Solonchak-soilscape. The Arenosol-Calcisol-soilscape of a neighboured dayet is used as rainfield.

**Keywords:** Aridity, IMPETUS, soilscape, Southern Morocco

## Indication of Phosphorus Nutrition in a Calcareous Soil in Bangladesh

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In a calcareous soil, phosphorus (P) nutrition appears to be a limiting factor for successful crop production. To make use of a strategic P nutrition to grow maize in Bangladesh soil (initial carbon 2.2%), a mixture of organic and inorganic P sources (23 kg/ha P) as F0, F25 and F50 (100% inorganic + 0% organic, 75% inorganic + 25% organic and 50% inorganic + 50% organic P, respectively from oil cake, bone meal and triple super phosphate) were used. In addition biological agents *Glomus manihot* (Gm) a (V)AM mycorrhizal fungus, *Bacillus megaterium var. phosphaticum* (Bm) a phosphorus-solubilising bacteria and *Rhizobium leguminosarum* (Rh) a nitrogen fixing bacteria were applied in a factorial design. A modified sequential phosphorus fractionation scheme by TIESSEN and MOIR (1993) was followed to determine the labile (0.5 M NaHCO<sub>3</sub> extractable), Al and Fe associated P (0.1 M NaOH extractable), Ca associated P (1 M HCl extractable) and residual P (Conc. H<sub>2</sub>SO<sub>4</sub> and H<sub>2</sub>O<sub>2</sub> digestible). pH of the initial soil was 7.6, which remained unaffected by the treatments. Available P (Olsen P) was found to increase from initial 6.0 upto 13.4 mg/kg soil after the treatment. All the treatments showed an increase in available P with the increase in organic sources except Rh, which showed a reverse trend. Sequential fractionation of phosphorus showed a large quantity of Ca-associated (HCl-extractable P) phosphorus between 450 to 485 mg/kg out of 793 to 865 mg/kg of total P. Among the treatments Rh was found to cause a decrease in NaOH and HCl extractable inorganic P with increased organic P source. Labile inorganic P (P<sub>ip</sub>) and organic P (P<sub>org</sub>) were varying most within the treatments. It ranged between 24.5 to 30.2 mg, 22.0 to 34.7 mg 2.7 to 12.9 mg and 0.8 to 10.9 mg per kg soil in NaHCO<sub>3</sub>-P<sub>ip</sub>, NaOH-P<sub>ip</sub>, NaHCO<sub>3</sub>-P<sub>org</sub> and NaOH-P<sub>org</sub>, respectively. *Glomus manihot* and *Bacillus megaterium var. phosphaticum* were able to enrich organic and inorganic P pools in comparison to *Rhizobium*. Organic sources of P fertiliser appeared to improve P availability to the crop and biological agents contributed to drive P among the organic and inorganic pools.

**Keywords:** Organic P source, P availability, P nutrition, phosphorus fractionation

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## Composting Pig Excrements in the Mekong-Delta

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In the Mekong-Delta, pig production is one major income source of farmers. The piggeries are small (3–5 sows) and the pig excrements are disposed directly to fields or into ponds or canals. Without treatment of the excrements soil or water may be polluted by pathogens originating from pig excrements.

Composting may be a way to sanitise the excrements by heat. In this study we composted pig excrements and investigated the sanitation and decomposition potential. In 100 litre basket ca. 90 kg substrate were treated. The substrates were pig droppings without additive, pig droppings with straw addition at two levels and anaerobically pretreated pig excrements. During eight weeks we monitored temperature, moisture, nitrogen and carbon content, organic dry matter as well as coliforms and *E. coli*. Weekly the substrates were mixed and total mass was recorded to calculate a mass balance.

Additionally nitrous oxide emissions were analysed during the maturing phase when N<sub>2</sub>O emissions were most likely. While the maximum temperature in the anaerobically pretreated substrate was less than 50°, the other substrates showed temperatures as high as 69°C indicating a good sanitation of these substrates. Pig excrements showed the highest temperatures, although this material had the poorest structure. This indicates that oxygen diffusion into the substrate and heat transport out of the substrate, both influenced by the structure of the material, need to be well balanced in small scale composting systems.

The mass balance, C- and N-losses will be presented in the presentation; at the moment these parameters are analysed.

**Keywords:** Biogas sludge, closing nutrient cycles, composting, Mekong-Delta, pig excrements, Vietnam

## Use of Bioresources in Agriculture and Horticulture of Vietnam

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The agriculture in Vietnam is characterised by an intensive monoculture in the arable land. This is the reason why in many regions decrease the soil fertility. To improve the soil fertility and quality more organic fertilisation as composts are necessary. In the first stage of the investigations the circuit of organic wastes and their different use in rural and urban areas of Vietnam was analysed. In the second stage experiments were carried out to clarify possibilities for utilisation of different biomass especially in rural areas. Investigations of the sources of unused biomass in the suburban and rural area showed sufficient organic waste materials as residues from harvesting or as residues from the processing in the industry. A large amount of these waste materials are burned for cooking in the households of the farmers. There are no investigations whether materials with high content of cellulose as sugar cane bagasse, sugar cane leaves, banana leaves or wood shavings can composted in a short time in good quality. It is known such materials with high cellulose content can compost only by use of special methods to accelerate the microbiologically decomposition. In the experiments the influence of different microorganism was investigated, adding of supplements and different humidity on composting process of the named materials. The aim of the experiments with composting was to get high quality compost suitable for cultivation of Vietnamese vegetables. For composting process of sugar cane bagasse and banana leaves normally more than 3 month are necessary. In the experiments were clarified that certain microorganism in a good calculated quantity have an important influence on the compost process. Using such composting methods in a period of 5 weeks compost with high quality was produced. Vegetable plants cultivated in this compost had better results in comparison with standard formulations. Resulting of these investigations and experiments composting method is developed appropriate for the conditions in humid tropical regions as Vietnam. Recommendations were elaborate for optimal exploitation of waste biomass in Vietnam in result of numerous experiments with composting.

**Keywords:** Compost quality, composting, organic fertilisation, sugar cane, waste material



## Subsession 4e: Soil Degradation

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## **Mainstreaming Sustainable Land Management in Agriculture, Natural Resource Management, and Rural Development Programs**

ERICK FERNANDES

*The World Bank, Department of Land Management, United States of America*

More than 1 billion people — two-thirds of them women — live in extreme poverty on less than \$1 per day. Transforming agriculture is a key element in achieving poverty reduction in many of the poorest countries, since most of the poor live in rural areas, and largely depend on agriculture for their livelihoods. Agricultural activities account for the greatest share of household production and consumption for the rural poor. Improving the productivity of agriculture has significant multiplier effects through the effects on wages and food prices. Current models of extensive agriculture and industrial growth have resulted in substantial risks to the natural resource base and to the environment. Globally, 12–15 million hectares of forests and substantial areas of grasslands and wetlands are lost annually. A further 5–10 million hectares are subject to severe degradation. The Global Land Assessment of Degradation (GLASOD) estimates 22 % of all cropland, pasture, forest, and woodland) have been degraded since the 1950s. Future sustainable development will rely heavily on intensified agriculture and sustainable land management (SLM). Policies aimed at improving the livelihood of the poor but which fail fully to address SLM issues will have limited or no impact. Technically, the causes of environmental decline are well understood. Sustainable land management (SLM) is closely linked with soil conservation, but the solution is not only technology-dependent. Poverty and land degradation have both social and environmental linkages. Providing enhanced farmer access to markets does little to address poverty if those farmers do not have the knowledge, technologies, and standards that the markets demand. Land redistribution in the absence of well functioning support for new land users can simply spread poverty and land degradation to new areas. This presentation briefly examines the considerable work on SLM done by the Bank, FAO, CGIAR and other stakeholders and discusses the World Bank's efforts to build upon existing scientific and traditional knowledge and experience to guide and prioritise future Bank investments in NRM to reduce poverty.

**Keywords:** Land management, transforming agriculture, World Bank



## Soil Degradation by Different Land Use Impacts in Tropical Rainforests and Consequences for Land Rehabilitation

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Despite the existence of international resource protection programs since the UNCED conference 1992 in Rio de Janeiro (AGENDA 21), rainforest conversion by non sustainable forest use as well as agricultural colonisation accompanied by clearcutting continues. Partly low fertile soils as well as fertile soils due to inappropriate use (p.e. mechanised cropping) led also in the Inner Tropics to a high portion of degraded soils.

Based on project studies in Ecuador/Bolivia (Amazon basin and submontane rainforests), West Africa (Rainforest and cocoa-systems) and Indonesia (lowland rainforest Central Sulawesi), consequences of clearcutting, annual cropping and agroforestry (cocoa) on soil and water nutrient cycling are presented. These researchs show that differing processes and budgets lead to soil degradation of varying reversibility. Depending on precipitation amount and soil nutrient status, annual cultures and pastures have significantly higher seepage nutrient losses than agroforestry systems (cocoa, coffee). Litterfall plays a more important role for soil nutrient supply than throughfall. By establishing agroforestry systems, nutrient enriched throughfall and litterfall can be used for the rehabilitation of degraded soils. The comparison between cocoa and citrus agroforestry systems and monocultures on Ultisols in Bolivia illustrates the differing development of soil nutrient status and points out the potential for sustainable land use even on nutrient impoverished soils after 30 years of slash & burn agriculture.

Project results from the eastern lowlands of Bolivia are used to develop a GIS-based methodology to identify potential landscape changes on a regional scale, including potential deforestation areas as well as areas with a high probability of soil degradation. The system development is based on the principles of the scenario formation and uses particularly fuzzy logic methods. The conversion of forest areas since 25 years (change detection), soil- and climate data and parameters related to people-environment interactions (driving forces) are used for practical decision rules. The results serves as an example for decision support in regional land use planning and to identify risk areas of soil degradation.

**Keywords:** GIS based analysis, Ivory Coast, land use, tropical rainforest, nutrient cycling, soil degradation, soil rehabilitation, soil nutrient status

## Assessment of Soil Erosion Using Caesium –137 on Cultivated Fields Following Natural Forest Conversion in the Kefa Zone of Southwest Ethiopia

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Soil erosion is a prime cause of loss of productivity of land. Decline in land productivity in most cases triggers the conversion of natural forests into agricultural land. The severe soil erosion in the highlands of Ethiopia is believed to be a result of agricultural conversion. The process of natural forest conversion is a growing phenomenon in the southwest region of Ethiopia. This study was aimed at assessing the magnitude and rate of soil erosion in a 24 km<sup>2</sup> sub-catchment in the Kefa zone of southwest Ethiopia, using the <sup>137</sup>Cs technique. A chronosequence of continuously cultivated fields of 2, 6, 12, 16, 20, 24 and 58 years after conversion were studied. A reference inventory of 2026 ± 176 Bq m<sup>-2</sup> with a coefficient of variation of 24.6 % was recorded indicating the applicability of the technique in the region. Although weak, the distribution of the <sup>137</sup>Cs inventories in the studied fields showed a declining trend (R<sup>2</sup>=0.2) with increasing years of continuous cultivation after conversion. The values of the younger and older fields were 1994 Bq m<sup>-2</sup> and 1164 Bq m<sup>-2</sup> respectively, indicating the greater extent of soil erosion in the older fields than in the younger fields. Estimated erosion rates using the Proportional Model (PM) and Mass Balance Model 1 (MBM1) also showed an increasing trend (R<sup>2</sup>=0.41) with increasing years of cultivation. Soil erosion rates in the cultivated fields ranged between 1 t ha<sup>-1</sup>yr<sup>-1</sup> in the younger field and 24.7 t ha<sup>-1</sup>yr<sup>-1</sup> in the older field. Erosion rate estimates for the sub-catchment were 11.6 t ha<sup>-1</sup>yr<sup>-1</sup> and 17.3 t ha<sup>-1</sup>yr<sup>-1</sup> by the PM and MBM1, respectively. An estimate made by using the Universal Soil Loss Equation (USLE) yielded 12.3 t ha<sup>-1</sup>yr<sup>-1</sup> validating the results by the prediction models and the applicability of the technique for soil erosion studies in Ethiopia. The results of this study showed that soil erosion in Kefa zone is on the verge of surpassing the tolerable level and it should of an immediate concern by conservationists and development planners at all levels.

**Keywords:** Caesium-137, Ethiopia, forest conversion, Mass Balance Model 1, Proportional Model, soil erosion

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## **Agricultural Development Patterns and Soil Degradation in South and Southeast Asia — A Regional Analysis Employing Multivariate Analysis and GIS**

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Soil degradation increasingly threatens food supply in many Southeast Asian countries. Socio-economic factors are considered crucial for the state of soils. Yet the understanding of links between socio-economic factors and soil degradation remains limited, with competing hypotheses existing about links to the most often cited causes of soil degradation: population pressure and poverty. At the same time data sources are limited, but allow for analysing the problem at a regional level. This paper contributes to the discussion by conducting a statistical analysis at a regional level. The analysis is based on a pressure-state-response framework, in which the influence of causal factors of soil degradation depends upon the framework conditions. This allows for varying links in different systems with similar natural and socio-economic conditions. The profiles of framework conditions are conceptualised as agricultural development patterns. The soil degradation data considered is the qualitative Assessment of the Status of Human-Induced Soil Degradation in South and Southeast Asia which technical data improvements and limited validity checks have been conducted. Further geo-referenced data sets available for the region are overlaid in a Geographic Information System (GIS). Poverty data have been assembled from both national Poverty Assessments and Human Development Reports.

Exploratory methods (factor, correspondence, and cluster analysis) were used to empirically structure context factors in form of agricultural development patterns. A subsequent analysis provided information on the incidence of different forms of soil degradation within clusters and on the influence of different factors on water erosion.

Results show, that by including socio-economic variables in regression analysis, explanation of water erosion can be improved as opposed to regressions including only natural conditions, showing a positive relation of poverty and population density with water erosion for the region as a whole. Clusters reveal clear differences with regard to the incidence of soil degradation. Regression analyses show differing importance of causal factors within clusters.

The approach proves useful to provide better knowledge about critical constellations of natural, socio-economic and land use factors with regard to soil degradation. Thus it enhances prospects for geographic targeting of measures against soil degradation.

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**Keywords:** Agricultural development, GIS, Multivariate analysis, soil degradation

## **Physical, Chemical and Biological Degradation of Tropical Soils in a Land Use System with Low Input**

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IMPETUS (an integrated approach to the efficient management of scarce water resources in West Africa) investigates the effects of global climate change on regional hydrological processes and on water availability in Benin and Morocco since 2000. Within this interdisciplinary project, the current situation of the soils developed in the catchment area of the river Aguima (30 km<sup>2</sup>, 100 km W of Parakou) and different kind of soil degradation in a land use system with low input were examined.

To determine the influence of agriculture on soils, several investigations were carried out in the pastoral used savanna and on cultivated land during the rainy season of the years 2001 and 2002. Runoff plots were installed on fields with different crops (cotton, yam, maize) and different tillage systems (rows, mounds) and in the savanna for measuring the current soil erosion by water. Additionally, the nutrient supply of crop land in settlements of different ages were compared. To determine the abundance and activity of soil fauna, the population density of earthworms and the production of worm cast were counted and bait-lamina tests as well as litter-bag tests were carried out in different used fields.

The measurements show the most runoff and soil loss on fields with crops planted in rows leading parallel to slope or in mounds. The investigations also indicate a decreasing nutrient supply with increasing time when no fertilizer are used and fallows are shortened. Furthermore, the low population density of earthworms and the reduced production of worm cast also show a biological degradation under the influence of agriculture.

So, land use systems with low input and shortened fallows in Benin lead to different kind of soil degradation which will consequently result in problems for food production in the future.

**Keywords:** Benin, low input land use system, soil degradation, West Africa

## **Application of Remote Sensing and GIS Techniques to Understand Major Processes Triggering Reservoir Siltation in the Highlands of Northern Ethiopia**

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The food security and other development endeavours of Ethiopia are highly threatened due to increasing rainfall variability and population growth. A growing population with a corresponding increase in the frequency of drought and famine forced the expansion of cultivation and grazing to steep slopes and fragile environments. This further accelerates the rate and processes of land degradation. One alternative approach for enhancing the food security of people in such a dryland environment is surface water harvesting. This scheme has been implemented in the Tigray administrative region of Ethiopia where significant achievements have been observed including a four to six fold increase in the annual yield of farmers as well as development of springs and wells behind reservoirs due to ground water recharge. However, these achievements are not sustainable as most of the reservoirs have lost more than 50 % of their storage capacity within less than five years of service. Currently, most of the reservoirs are not providing the intended service due to accelerated siltation problems. This has brought a big economic implication and resulted in a change of government strategy from “reservoirs to small ponds”. Despite the fact that soil erosion is a major land degradation process in the region, no scientific attempts have been made so far to investigate the dynamics of siltation processes and controlling factors. This paper demonstrates the need for and approaches to an integrated approach to understand the determinant factors of reservoir siltation by combining different data layers from remote sensing, field surveys and existing maps in a GIS-based modelling approach. Both the spatial dynamics of geomorphologic and anthropologic factors are analysed and their relative contributions to reservoir siltation investigated. Terrain and its derivatives, land use/cover, drainage network and surface lithology are used as proxies to investigate the spatial variability of sediment yield at a catchment scale. Our approach could be considered as a simple and fast way of prioritising hotspot areas of erosion for appropriate management interventions particularly targeted to ameliorate the major causative factors at their specific locations.

**Keywords:** Erosion, GIS, food security, modelling, Northern Ethiopia, siltation, Tigray

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## Nutrient Losses — The Role of Bushfires in the Savannah of Northern Ghana

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The research was conducted in the northern Ghana to investigate the destructive power of bushfire in terms of nutrient losses. The losses were estimated in three sites with different vegetative structures; grass/herbs with scattered trees and shrubs (Sambu), open woodland savannah (Jimle) and woodland savannah (Dagomba-Line).

The nutrient loads contained in the fuel load before fires, and that of ash were subsequently compared to determine the fluxes of the micronutrients. The magnitudes of the fluxes were greatest in the herbaceous vegetation with scattered trees and shrubs where fuel load were the highest at  $6.7 \text{ t ha}^{-1}$ . In these sites 41–93 % of all measured nutrients in the fuel load were transferred to the atmosphere or lost from the sites during the bushfires. For each nutrient, the proportion transferred to the atmosphere as entrained ash was calculated by assuming that calcium was not volatilised during bushfires. If the transfer of entrained ash represents local redistribution only, then rainfall accession and deposition of these particulates should replace most of the losses of all the nutrients except nitrogen (N) and to some extent phosphorus (P). Estimates of biological fixation of N appear to be insufficient to replace the annual losses of N. Further research is required to confirm this because reliable estimates of rates of non-symbiotic fixation in this area are scanty, and possible role of non-symbiotic and other flora are unknown.

The study concludes that, under a regime of annual bushfires in which the burns are complete, the nitrogen reserves of savannahs similar to those in northern Ghana may be depleted, and this may subsequently lead to the unsustainable loss of nitrogen. To reduce the likelihood of this occurring, the contribution of fire to nutrient cycling would need to be reduced.

The current work also indicates that, the transfer of P to the atmosphere during bushfires is much greater than previously recognised. Natural replacement of P losses is likely to be slow in this environment because inputs in rainfall and weathering in rainfall and from soil mineral are small.

**Keywords:** Bushfires, nutrient losses and fuel load, Savannah

## Effecting of Soil Degradation on Crop Productivity in the Upland of Vietnam — A Case of Ba Be District, Northern Vietnam

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The mountainous areas of Vietnam cover  $\frac{3}{4}$  of the national territory, with much difficulty for agricultural production. Nevertheless, the cultivated land /capita decreases annually (it was 0.109 ha/capita in 1989, and only 0.089 ha in 1999. According to UNDP, with a projected in the year 2010, the cultivated land/ capita will further decrease to 0.036 ha). The conflict of increasing population on one hand and decreasing land/capita on the other hand leads to overuse and misuse of land - reason for soil erosion and degradation, which result to decline crop yields and hence decrease income as well as threaten food security situation for the farmer in this area. In addition, the off-site effects of soil erosion often have broader economic and environmental implications including sedimentation, flooding, and reduced water quality resulting in poorer living conditions for the people.

The examination of soil samples shows that pH value and base saturation in the area clearly decreased after cultivation for few years. The degradation of soil from the first to the fourth year of maize cultivation is indicated clearly by a decrease of organic matter, total nitrogen content and the cations exchange capacity between forestland and first year after slash and burn or between the first year and the fourth years after slash and burn. This change is due to the different level of soil erosion in the plot of first year to fourth year cultivated land. The availability of P content after Bray in both soil depths (0 to 30 cm and 31 to 60 cm) were very low especially in the plots that was used for long time and tended to decrease fast from the first year to the fourth years after cultivation. This indicates that land becomes degraded fast after few years cultivation. The reason lies in the fact that partly available P is lost through erosion process and also due to iron and aluminium enrichment at low pH values leading to reduce phosphorus availability through the irreversible phosphate fixation. Therefore, long time use of land without any soil conservation measures (soil erosion control) soil degradation leads to unusable grassland.

**Keywords:** Land resource, shifting cultivation, soil degradation, sustainable land use, Vietnam



## Assessing Soil Degradation in Eastern Bolivia

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This study attempts to develop a GIS-based methodology for the assessment of potential soil degradation areas in the main cultivation zone in the eastern Bolivian lowland. The region is characterised mainly by highly mechanized large scale agriculture.

Variables taken into account are data about soil (soil properties), climate (precipitation), land use (utilisation, system, cultivation period) and relief (topography) as well as land cover (type), administrative (concessions, colonisation areas) and infrastructure data (road network, network distance, settlements). Information about soils were derived from a departmental land use plan (PLUS) and several more detailed soil studies. All data were compiled together in a GIS data base.

We assessed the spatial and temporal patterns of deforestation as well as the conversion into different land use or land cover classes by processing 2 adjacent Landsat images (230–72, 230–73) for the years 1984, 1992 and 2001 each. The study area is limited to the area common to the images. It is located between the Andean foothills to the west and the Brazilian shield to the north-east and covers over five million hectares of mainly flat land. Almost 1.200.000 ha forest were cleared between 1984 to 2001. The estimated annual deforestation rate increased from 40.339 ha by 1992 to approximately 97.500 ha by 2001. Thus, 73 % of the total deforestation has occurred in the 1990s.

The soils are predominantly highly fertile (alluvial deposits) but due to an inherently fragile soil structure susceptible to compaction. Hence, a significant proportion of the soils have different levels of limitations for mechanized agriculture and requires careful management. According to the land use plan, 871.338 ha (82,5 %) of the soils in the study area used for cropping in 2001 have severe limitations, whereas 132.695 ha (12,6 %) are unsuited for cultivation. However, the combination of an inherently unstable soil structure with inappropriate soil management techniques and harsh climatic conditions (strong winds and a distinct inter-annual variability in precipitation) led to increasing soil degradation processes, followed by declining yields. Low land prices makes conservation unnecessary, so that ongoing soil degradation is most likely.

**Keywords:** Bolivia, GIS, soil degradation



# Session 5: Water and Energy Resources Management

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## Subsession 5a: Water Policies and Institutions

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## Hydropower Development in Nepal — Local Responses to Technology and Formal Institutions

KAVITA RAI

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Currently in Nepal, there is a big push for large hydro projects as the dominant national strategy not only for sectoral gains but also as an engine for country's overall economic development. Policy makers emphasise that the exploitation of rural natural resources (particularly, land and water) for a larger public gain will ultimately lead to a win-win situation for all. Within this context, formal institutions (laws, acts, policies, and guidelines) provide the framework for direct technological intervention strategies. In terms of outcomes of such intervention for the people affected, formal institutions concentrate on compensatory packages, financial as well as non-financial. There is limited research on how these institutions actually translate at the local rural level in regard to distributional outcomes particularly based on notions of equity or inequity. There is even less research on how the newly implanted technology impacts on people's access, dependence and exploitation of resources, both financial and natural (land and water), whether they are displaced or not by the hydro projects.

This presentation will focus on results on the above, part of an ongoing Ph.D. research. It will be based on a qualitative case study on localised responses to Nepal's largest hydropower project, the 144 MW Kali Gandaki 'A', in mid-western Nepal, about 180 km west of Kathmandu. It studies the processes through which local actors and groups access knowledge and information of the technological intervention and its associated formal institutions in both the compensatory and post-compensatory stages. It also tries to assess levels of influence and power within specified social structures (caste, class, ethnic group and patron-client relationships) on such access to knowledge and information and how it is further used to affect resource redistribution, both financial and non financial. This will be fed back into policy processes of large hydro, particularly dam intervention, as Nepal (along with India) readies itself for grander projects. It will also help set lessons for debating further on whether large dams are the answer to a poor country's development under the current institutional context.

**Keywords:** Dam, hydropower, institution, natural resource management, policy, social structure

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## Challenges and Instruments of Participatory Water Resources Management Systems in Brazil

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Brazil is implementing water policies and legislative instruments for water management in conformance with the Agenda 21. According to this agenda, the use and protection of surface water and groundwater are coordinated at river basin level and include the participation of the civil society. Integrated river basin management, with participation of the state, municipalities and the public sector has a long tradition in some Brazilian states, like e.g. the Integrated System of Water Resources Management (SIGRH) in the state of São Paulo, created in 1989.

Brazilian river basin management models are facing new challenges and opportunities raised from the increasing participation of the civil society and the new advances of information technologies. The success of river basin management systems relies upon coordinated actions, including provision of and access to information as well as the capability to correctly interpret and use them. In this paper we discuss the institutional and participatory aspects of river basin management systems and the importance of information exchange between the stakeholders for planning and operational purposes. We show that information interoperability supports stakeholder involvement, contributing to overcome institutional barriers and to enhance the legitimating of water committees. The regional aspects of water resource management in Brazil, including water availability, climate, educational and cultural aspects as well as political tradition, are illustrated by comparing the semi-arid rural region of Paraíba State with the industrialised humid region of São Paulo. The water resource management system and water politic in Brazil should consider these regional differences while establishing plans and actions.

**Keywords:** Brazil, information systems, institutions, stakeholder participation, water management, water policy

## **Water Pricing and Decentralised Irrigation Management in Andhra Pradesh — Schism Between Objectives and Realities**

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Installation of decentralised management institutions and collection of near economic value of water are considered important for efficient water management especially in irrigation sector in developing countries. The rationale and objectives of such initiatives are improved revenue collections, minimised wastage of water, enhanced operation and maintenance, efficient and equitable service delivery, and environmental improvements.

An innovative experiment for decentralised irrigation management was initiated in Andhra Pradesh (AP), India, under Participatory Irrigation Management programme. As part of this initiative, policy, institutional and fiscal reforms were carried out for achieving the set objectives. AP Farmers' Management of Irrigation Systems Act was passed in 1997 with objectives of ensuring equitable and reliable water supplies, bridging the gap between irrigation potential created and utilised, entrusting operation and maintenance of systems to elected Water User Associations (WUAs) and efficiency in water usage and tax collection.

Greater responsibility was accorded to elected representatives of water users through forming of nearly 10,000 WUAs with the responsibilities of irrigation management. Similarly, under fiscal reform, water charges were enhanced by three times as a step towards realisation of economic value of water.

In this study the authors intend to evaluate and assess the extent to which the above objectives have been achieved. Further, it will examine the systemic and policy limitations, if any that inhibit realisation of the objectives. The focus of the study will be on the water pricing aspects of the reforms in irrigation management. Primary evidences suggest that there is no synchronisation between the revenue collection and the amount of water released due to lack of coordination between the concerned departments such as revenue and irrigation departments. This lack of functional integration is one of the major limitations in the water revenue collection and management. Because of electoral compulsions the commitment of the state to implement the intended change process is slow which in turn puts limitation on the management process. There is only additionality to management structure and limited coordination between power and function resulting in notional managerial autonomy.

**Keywords:** Decentralisation, equity, water institutions, water pricing, water user associations

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# Subsession 5b: Water Management Concepts and Water Use

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## Water Shortage— An Agronomic Challenge

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Due to the principal dependence of plant growth on water supply and to the increasing worldwide demand of water, there is an urgent need to save water in irrigated farming and to grow a larger portion of staple crops under rainfed conditions. Climatic water shortage occurs most frequently in arid and semiarid tropics and subtropics. However, productivity is also lowered widely in subhumid climates by 'latent water shortage'.

Water can be saved in irrigated crop production by improving supply channels, irrigation systems and water management. Interdependencies among these possibilities and limited financial resources will strongly restrict progress and, hence, integrated approaches are required.

It is of fundamental importance for crop production — whether irrigated or rainfed — to avoid latent water shortage during the most susceptible phases of yield formation. Agronomic strategies to save water can be developed according to the concept of the resource-use efficiency, or rather the water-use efficiency with its 3 components: uptake-, conversion-, and transformation-efficiency.

Improving uptake-efficiency is useful at locations where rainfall before or during the vegetation period saturates soil moisture down to deeper layers which can be exploited by deep-rooting of crops and, thus, bridge lack of water during the later season. Such an increased water-uptake can be achieved by agronomic measures or by breeding.

With regard to the evapotranspiration-efficiency (ETE), the second component of WUE, differences among species are well known. Unfortunately, determination of varietal differences are very laborious and time-consuming and, hence, rarely available. Varietal ETE can be indirectly determined by D C13-discrimination analysis. However, expensive sophisticated devices are preventing a wide-spread use of this indirect method. Evidence is provided that short-term monitoring of the ratio of photosynthesis and transpiration may be a useful indicator of ETE.

The third WUE component is the harvest index representing the efficiency of the transformation of biomass into yield. Since strong increment of this index has been the basis for all high-yielding varieties, larger room for varietal improvement exists only in species that have not been subjected to intensive breeding.

**Keywords:** Breeding , husbandry, irrigation, water-saving, water-use

## **Aymara Indians in Chile — Water Use in Ancestral Cultures at Odds with Water Rights in Modern Times**

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South American Aymara culture, as well as Inca Empire were born high and above, in the vicinity of Titicaca Lake, over one of the highest plateaus on earth, in the nearness of active volcanoes and snowy peak summits. Soon the Indians descended to the valleys, following rivers and streams, fed on Andean ices, building up terraces and carefully channelling the precious liquid in order to irrigate potatoes and quinoa. Whereas the Incas disappeared, Aymaras persevered in Extreme Northern Chile, raising llamas and alpacas, growing vegetables and fruit trees at lower altitudes, even in desert areas where ancestral “canchones” and Spanish adopted “socavones” became common techniques, intended to capture either superficial and subterranean waters from dry pampas and nurture food crops in beautiful oasis. However, water resources are running scarcer these days, for higher return activities developed in port cities, all together with rich copper, nitrates and other sorts of mine enterprises, gave way to a recent water code (1981) that turned the contended liquid into a transacting commodity, totally separated from land or property rights. During 2003 and 2004 hotter summer months, a joint Portuguese-Chilean team, led by the Portuguese Tropical Institute, field researched Aymara Indian communities in extreme northern Chile, a millenary ethnic group still stubbornly inhabiting hard to reach adobe houses settlements, located up the Andes and high oasis valleys, persevering against all odds their nature respectful farming traditions. The paper discusses differences between modern Chilean policies and ancestral Indian ecological practises related to water use and management in the First Region of Tarapacá.

**Keywords:** Canchones, irrigation channels, oasis valleys, socavones, terraces

## **Decentralised Irrigation Management and the Role of the State in Eastern Burkina Faso**

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Decentralisation of water management responsibilities has been one of the main international policy solutions for efficient and sustainable water management. In Burkina Faso, one of the countries with increasing water scarcity problems, public irrigation development was initiated in the 1960s. The following political trends had the general effect that dominant authority of the central government was reduced and that the significance of local level decision-making was increased. Due to more recent decentralisation policies the departmental and regional state authorities have obtained more legislative power and responsibilities regarding conflict management and decision-making support for the farmer users' groups of the irrigation systems. In the same time the state agricultural organisations that were expected to provide technical support have been reduced.

From July 2002 to October 2003 a study was conducted in the Eastern part of Burkina Faso in order to analyse the different institutions dealing with water management and the national policies, their implementation and the outcome on the local level management. In this paper the management structure and situation of two irrigation systems is described, and the influence of the local state authorities as well as the influence of the agricultural extensive services and other local authorities, such as chiefs, is analysed. The research shows that the policies implemented at the local level have had different outcomes regarding farmer management in the two cases. This partly due to its location and the connected land claims, though also the social, cultural and historical context as well as the different extent of intervention of the local state authorities play a large role. Accountability and credibility problems, rent-seeking activities, social and political relationships, and disrespect of the (in)formal authority structures are among the factors that have influenced water management within the two systems. The challenge is to support and strengthen these local management structures as well as the local state administration in the execution of their responsibilities in order to come to a more efficient management system.

**Keywords:** Burkina Faso, decentralisation, farmers' organisations, irrigation management, state

## Potentials and Limitations of Wastewater Re-Use in Rural Areas — A Comparison between Tunisia and Jordan

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Recycled wastewater provides a potential alternative resource for water scarce regions. Treatment costs are an obstacle for purification up to drinking water quality, but water of lower quality may still be used for irrigation purposes. Research results from Tunisia and the Jordan Valley indicate that impacts from the use of treated wastewater on agriculture and rural development depend — at least in the short and mid-term run— on the socio-economic and institutional environment of farming systems rather than on applied water qualities. Wastewater already amounts to around 5 % of the total available water resources in Jordan and Tunisia and will increase to a share of more than 15 % within the next 30 years. Potentials and limitations from this alternative water resource vary due to differences in the context of farming systems and agricultural development. Similarities are likely to arise from the perception of consumers with regard to products from wastewater irrigation and from lower variations in water supply. Wastewater use in agriculture already takes place in Jordan. Further amounts are likely to replace for currently used freshwater in irrigation. Administrative regulations and restrictions for wastewater use restrict cultivation alternatives. Results are an increase in the required minimum land size of sustainable farming systems, a decrease in the number of farms in the Jordan Valley, lower labour requirements in agriculture and impacts on the market supply with specific products. Tunisia, which applies comparable administrative regulations, intends to use wastewater in a first step for extending its area of arable land. Predictable consequences are the increase of income opportunities for farming systems that are based on agriculture, but also limitations for livestock holders, who currently rely on the extensive use of communal areas. The comparison of the results from the research programmes in Jordan and Tunisia emphasises the need for a thorough examination of the individual case in the run-up of approaches to introduce or enhance the use of treated wastewater in agriculture. Recycled water is a valuable resource of rising importance but appropriate plans for its use have to take into account measures with regard to potentially substantial secondary impacts.

**Keywords:** Agriculture, Jordan, recycled water, Tunisia, waste water

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## Nutrient Fluxes in Waste Water in Farming Systems in the Mekong Delta

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The Mekong Delta is strongly based on agriculture, 75 % of the 40.000 km<sup>2</sup> land is agricultural land. 85 % of the population in the Delta (17 million) are farmers living in communities which are split into small parcels along the water ways.

Human organic sanitary waste as well as the excrements of about 2,9 mio pigs, 46 mio poultry and other livestock are disposed mostly directly into the surface water. While most of local farmers depend on the surface water for drinking, irrigating their crops, fishing, aquaculture, etc., protection of this water source is crucial. Their organic sanitary waste can be valuable when used for fertilising soil for cropping or growing fish but may harm the environment — especially the water — when spilled uncontrolled.

Within this project SANSED water quality shall be improved by developing site-adapted-systems that reduce the nutrient losses and produce effective fertilisers for agriculture.

To optimise the nutrient reuse quantitative nutrient fluxes through households and water treatment systems are required. Therefore nutrient concentrations within two typical small farming households in Can Tho Province using biogas systems in combination with fishponds have been monitored regularly for one year. Water and sludge samples have been taken and analysis include field parameter (pH, electric conductivity, dissolved oxygen), nutrients (nitrogen, phosphorus, potassium) Carbon, Heavy Metals, and characteristic waste water parameters BOD, COD, *E. coli*, Coliforms.

By passing the biogas system first and the fish pond second the concentrations of COD, BOD<sub>5</sub> are reduced significantly i.e. COD concentrations in the inflow reach around 10,000 mg/l, in the ponds it is usually below 50 mg/l. Pond concentrations sometimes even reach the Vietnamese Standard for surface water (COD < 10 mg/l).

Fluxes have been estimated out of these data. A flux model through the systems has been developed that may be used to optimise the process of waste water treatment and agricultural production.

**Keywords:** Biogas, nutrient fluxes, waste water

## **Integrated Economic-Hydrologic Water Management and Planning Model for the Khorezm Region in Uzbekistan**

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Water availability and an effective and sustainable management of water resources is an important factor in social and economic development. This applies notably for the case study area. The highly arid area Khorezm is situated in the Central Asian Republic of Uzbekistan and the Amu Darya delta region. The Amu Darya is directly flowing into the Aral Sea, but due to historical and recent expansion of irrigation projects and climatic fluctuations the water is often not feeding the Aral Sea any more. The region is highly dependant on water for irrigation purposes. But inefficient water consumption and management result in drastic ecological, social, and economical problems like rise of soil and water salinity, water scarcity and competition, declining yields, health problems or rising groundwater levels. This development and an increasing competition among water users within the region and between up- and downstream areas along the river calls for a more efficient water allocation and management approach for the region. In this study an integrated economic-hydrologic water management and planning model for Khorezm region is developed with the main objective to determine different water users and water using patterns and to find out strategies for a more efficient allocation and management of water resources that also allows the analysis of alternative water policy scenarios. The described research is part of the Uzbekistan project “Economic and Ecological Restructuring of Water and Land Use in the Region Khorezm (Uzbekistan)” of the Center for Development Research in Bonn. The modelling system is developed as a node-link network where nodes represent physical entities like water sources and demand nodes (river nodes, reservoir, groundwater, drainage, evaporation ponds, agricultural demand sites) and links represent the linkage between these entities. The water allocation model is programmed in Gams (General Algebraic Modelling System) and is made of a system of non-linear differential equations. The development of such a framework of analysis can be a step to integrate different disciplines (natural sciences, economics, social sciences) to find out a better water management including efficient, equitable, and environmentally sustainable water allocation mechanisms.

**Keywords:** Integrated hydrologic-economic model, irrigation, node-link network, river basin model, Uzbekistan

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## **Acceptance Analysis of New Technology for Decentralised Water Management — A Case Study of Operating Farm Households in the Mekong Delta, Vietnam**

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According to the “Vietnam Environment Monitor 2003 — Water”, clean drinking water is provided to approximately 60 % of its population. Due to the dynamic development of Vietnam’s industrial and agricultural sector in the last decade as well as to its growing population, there is increasing evidence of pollution of surface, ground and coastal waters. Thus especially in the Mekong Delta rural water supply and adequate sanitation become an important topic. Implementation of decentralised wastewater treatment systems to use faeces in agricultural production in a hygienic, economic and ecological appropriate way is seen as an effective loop-approach to this water and health crisis. With an interdisciplinary team the SANSED-Project aims to link water management with agriculture in the Mekong Delta, its first experimental region. Farm households’ acceptance behaviour represents a key role for sustainable development. Therefore this research determines and analyses factors that affect farmers’ attitude, acceptance and diffusion of ecological sanitation technologies like biogas plants, modern latrines as well as the use of organic substrates for agricultural production in integrated small scale farming systems. Three villages of the Can Tho Province were selected. After a preliminary study in the research area, a standardised questionnaire was elaborated, with an integrated research approach combining various dimensions of farmers’ environment as well as the main attributes of the innovations respectively. Within the stratified, disproportional sample 218 farm households were interviewed. Additionally expert interviews with representatives of the local government, universities and other institutions were realised. This research will describe current socio-economic conditions and their significance to the actual use, treatment and behaviour concerning garbage and wastewater. Further the results will clarify attitudes and acceptance towards the evaluated innovations and thus allow recommendations which contribute to a sustainable development of optimised farming systems preventing water pollution and water-born diseases.

**Keywords:** Acceptance, biogas, ecological sanitation, Vietnam, water management

## Hydro Economic Modelling in Southeast Morocco

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Changing climatic, economic and socioeconomic conditions have major impacts on resource availability and rural poverty in developing countries like Morocco. In this context the poster presents preliminary results of the analysis of the interdependencies between available natural resources, above all water, and the economic, socioeconomic and demographic development. The aim is to develop different scenarios and to work out development strategies until the year 2020. The scenarios focus mainly on the Draa basin in south-east Morocco.

For the development of the scenarios different tools are used:

- the Crop Water Requirements calculator (CWR calculator)
- the Water Poverty Index (WPI)
- the Integrated Model of the Draa valley (MIVaD)
- a basic data system, linked to an Internet based interactive mapping tool (Maroc-Info) to depict the results.

The CWR calculator is a tool 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. The Water Poverty Index is a holistic water management tool which takes into consideration both socio-economic and physical factors. It can be used for the prioritisation of water needs and to monitor progress in the water sector. Originally it was developed by the Centre for Ecology & Hydrology of the United Kingdom and can be used on national, regional and community level. The integrated model of the Draa valley is based on the river basin model developed at IFPRI. Based on statistical data about the region scenarios concerning the optimisation of water use among agriculture, household, and electricity generation from hydropower are developed. The basic data and the results of the simulations are visualised in an interactive form in MarocInfo which permits an easy access via Internet.

**Keywords:** Modelling, Morocco, water

## Interaction of Drought and Nitrogen Availability on Drought Tolerance Mechanisms of Some Sudanese Pearl Millet Genotypes

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Five Sudanese pearl millet *Pennisetum glaucum* L. R. Br. genotypes were cultivated in climate chambers and treated with low (N<sub>1</sub>), medium (N<sub>2</sub>) and high (N<sub>3</sub>) nitrogen supply by adding NH<sub>4</sub>NO<sub>3</sub>. Drought was induced 36 days after sowing (DAS) by withholding water until the soil reached an pF value of 4.5, which was then maintained by watering the pots to a certain weight twice a day. The plants were harvested at 45 DAS. Measurements of the gas exchange and water potential of the leaves were conducted between 43–44 DAS. For the analysis of the osmotic potential and several metabolites, the lamina of the uppermost fully expanded leaf was immediately frozen in liquid nitrogen.

The contribution of minerals, sugars and proline to the osmotic adaptation of the leaves to drought was investigated. The osmotic adaptation of the leaves to drought was mainly caused by a drastic increment of the potassium concentration. The nitrate concentrations were negligible in controls and the drought treated plants with low nitrogen supply, but rised up to 80 mM in the leaf tissue sap of the drought stressed N<sub>3</sub> plants, where it contributed to the osmotic adaptation. Because of their high nitrate levels leaves grown under drought and high nitrogen availability are not recommendable for the use as animal fodder. Proline in the leaf tissue sap increased from very low levels in the controls (up to 2 mM) to the stressed plants with values around 10 mM in N<sub>1</sub> and around 30 mM in N<sub>2</sub> and N<sub>3</sub>, where it contributed slightly to the osmotic adaptation. Although the sugars contributed significantly to the osmotic potential in all treatments, they played no role in the osmotic adaptation to drought.

The degree of the decrease of the water potential of the drought stressed leaves was affected by the nitrogen supply. The decline of the net CO<sub>2</sub>-assimilation rate in response to drought was mainly due to nonstomatal factors and modified by genotype x nitrogen supply interaction. Drought had no major effect on the total nitrogen uptake and did not hamper the nitrogen translocation from the root into the shoot.

**Keywords:** Drought, gas exchange, osmotic adaptation, pearl millet

## **Lateral Water Flow and Transport of Agrochemicals in the Soils of a Sloped Litchie Orchard in Northern Thailand — Concept and Experimental Setup**

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During the last decades a change in land use has been accompanied by an increased input of agrochemicals in mountainous regions of Northern Thailand. Particularly in sloped areas agrochemicals may be lost to the streams by lateral flow and transported to the lowlands, thereby contaminating drink and use water. Our research aims at measuring and modelling water flow and agrochemical transport at hill slope scale in Northern Thailand. Special emphasis will be put on lateral surface and subsurface water flow and solute transport as well as on the fate of pesticides in soil. During two rainy seasons plot (2 m × 3 m) transport experiments will be carried out. Two pesticides will be applied and seepage water will be collected at a profile with wick samplers and surface runoff collectors. Also water content and suction will be measured. Soil samples will be collected at the end of the experiment and residual solute concentrations will be analysed. Twenty-five soil samples taken at the hill slope will be analysed for clay content, pH, and Corg. Further, sorption-desorption isotherms and degradation under different moisture and temperature conditions will be measured with a subset of 10 samples. Pedotransfer functions will be estimated, with which pesticide sorption can be assessed from basic soil variables. Pesticide loss at hill slope scale will be calculated with a simulation model. To receive independent data for testing the model two flumes have been installed upstream and downstream in the downhill river, which allow for detection of pesticide loss from the whole hill slope. Data from the second year will be used to validate the model. Surface runoff is expected to have the largest impact on pesticide loss. After the experiments the prediction of pesticide outwash via surface and subsurface water flow depending on slope, pesticide- and soil properties will be possible. Detailed knowledge of pesticide transport, sorption and degradation processes will make it possible to adjust application in order to minimise leaching and improve water quality. The pedotransfer functions will be helpful in the future to evaluate the potential of pesticides to contaminate ground- and surface water.

**Keywords:** Degradation, hill slope, lateral flow, pesticides, soil, sorption-desorption, water quality

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## **Effect of Land Use Changes on Sediment Load in Zagbo River Catchment in Southern Benin**

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Agriculture is often the most important economic sector in many developing countries. In Benin 80 % of the active population is engaged in agricultural activities and agriculture contributes up to 37 % of the GDP . Several African countries have chosen the option to increase agricultural production via an expansion of the cultivated surface area. According to the FAO (2004) the Agricultural area in Benin has increased from 1,442,000 ha in 1961 to 2,815,000 ha in 2001, which means an increase of 51 %.

Due to its history as central territory of a formerly important kingdom, the Abomey plateau is heavily influenced by this process and currently has a population density of 225 inhabitants per km<sup>2</sup> by the census in 1992. Nowadays, the plateau is characterised by soil degradation, scarcity of forest cover and low agricultural yields. The challenge is to bring to a halt the negative trend in agricultural productivity due to soil loss and soil degradation, and to reverse the deterioration of the productive base (soil).

In order to assess the sediment load on a regional scale which may arise from tremendous anthropogenic activities, a geographic information system on the relevant surface properties will be generated for regional modelling. This research applies the Soil and Water Assessment Tool (SWAT) model to the Zagbo River catchment area in Southern Benin to quantify the sediment load based on the changes in land use over the years. The DEM of the southern part of Benin, soil maps from the SOTER database and land use/land cover maps, digitised stream lines (Zagbo River) and weather data was used in this model to generate maps of sediment load potential for different land use scenarios and thus help in identifying the major sources of sediment movement.

**Keywords:** GIS, modelling, sediment yield, SOTER, SWAT, watershed hydrology

## Rural Drinking Water Supply in Benin, West Africa

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Benin, located in a transition zone between the wet and dry tropics of West-Africa, is suffering from temporal and spatial difficulties in drinking water supply. Although the total amount of renewable water resources per capita and year accounts for 3954 m<sup>3</sup> (UNO 2003), there are places and times in Benin, where and when rural women have to spend up to 10 hours a day to fetch water for their household members.

Water stress situations in Benin are due to temporal and spatial variability of rainfall, geo-hydrological conditions and missing financial means to afford modern technical supply facilities. Such equipment, like boreholes with handpumps, are reliable and applicable water supply facilities for rural areas of Benin. The drilling depth of boreholes is deeper than this of excavated wells and usually reaches the groundwater table even in dry seasons. Another advantage of boreholes with handpumps are hygienic conditions, because they are sealed, so that pollution of water resources is naturally less likely to occur than with open water resources.

The disadvantage of boreholes with handpumps is that they are more cost-intensive than other drinking water facilities, like wells for example, and that they require maintenance and repair work. The result of an investigation, conducted in 34 villages in North Benin (January-April 2003), shows, that 32 % of the inhabitants have access to improved water supply facilities (boreholes with handpumps or excavated modern wells), but only 12 % of the inhabitants have access to improved water supply facilities, which are functioning all the year.

An intensification of maintenance skills of the concerned population and better access to spare parts should improve the reliability of drinking water facilities in rural Benin.

**Keywords:** Benin, drinking water, rural water supply, West Africa

## Water Resource Availability and Concepts for Traditional Water Use in the Inner Tropics

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The hydrological functions of tropical rainforests are a substantial argument for forest conservation. Global climatic variability (p.e. impact of El Nino Southern Oscillation) and regional deforestation often leads to an increased variability in discharge patterns, causing large fluctuations in water supply and water quality. On the other hand the demand for water rise due to population increase and economic development. In the tropical developing countries forest conversion continues, specially with accelerating rates in Indonesia (2 million . ha since 1996 every year). Studies that attempt to quantify the impact of El Nino and deforestation on the water yield and the seasonal water availability are still scarce. Concerning changes in the dry season flows, measurement results of various studies are ambiguous. Considerable increase or decrease of flow during dry season were observed. These changes can have a severe impact on rural water supply systems in regions of the humid tropics where the amounts of streamflow in the dry season are already critical and further reductions will limit the water supply. Further on ENSO years in South East-Asia (research area Central Sulawesi) are characterised by reduced rainfall during the dry season which led to a shortage of water availability. Concepts that analyse domestic traditional water use in the rural area, perceptions of the village people on water availability and water quality and hydrological modelling to assess the water resource situation and to study ENSO scenarios and rainforest conversion scenarios for the humid tropics are still scarce. Results of ongoing interdisciplinary research projects in Central Sulawesi (Indonesia) for two catchments will be presented (DEKLIM-C: [www.gwdg.de/impenso](http://www.gwdg.de/impenso) and SFB-552: [www.storma.de](http://www.storma.de)). The physically based water balance model WASIM-ETH was adapted for the humid tropics and ENSO scenarios as well as forest conversion scenarios demonstrates the response of the hydrological system to rainfall anomalies and land cover changes. Combining this with increasing domestic water use (rapid growth of settlements at the rainforest border) and to keep sufficient wet rice production for the future the rural water management (community based) must combine traditional low cost water use systems with the prediction of water supply by water balance models.

**Keywords:** Central Sulawesi, hydrological modelling, Indonesia, land cover change, rainforest conversion, rural water management

## Drought Performance in Grain Sorghum and Millet

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Grain Sorghum (*Sorghum bicolor* L MOENCH) and Millet (*Panicum miliaceum*) serve as one of the most important staple cereals in drought-affected areas of our globe, where annual rainfall is at its minimum. Their ability to grow and generate substantial yields under water limiting conditions has been attributed to their drought avoiding and tolerating characteristics.

Three genotypes representing three different maturity (early, middle, and late) groups of each crop were cultivated in sand/nutrient media in a greenhouse. Control plants were maintained at field capacity (soil water potential; SWP at  $-60$  to  $-80$  h year<sup>-1</sup>). Stress was imposed at 50% blooming by withholding water supply from an automatic irrigation system until SWP reached  $-200$  h year<sup>-1</sup> and was maintained for ten consecutive days. This was followed by re-irrigation to field capacity until harvest.

The objectives of this experiment were: (1) To use photosynthetic gas-exchange parameters to analyse the reaction of both crops to drought; (2) To monitor and measure the growth and development of both crops, and the above ground biomass accumulation under both treatments; And (3) To compare the water use efficiency by looking at evapo-transpiration efficiency (ETE) and harvest indices.

Generally, water stress had a negative effect on the photosynthetic process of both crops. However, this was stronger in grain sorghum than in millet, with the late maturity genotypes of both crops been mostly affected. Also, the yields of sorghum were more drastically reduced by water stress than their millet counterparts. This was also the case for the above ground biomass and tiller production. The harvest indices of millet were relatively stable though not optimal as compared to their sorghum counterparts. The water use efficiency of the various millet maturity groups was significantly higher than their sorghum counterparts both under controlled and water stress conditions.

These results can be used to facilitate crop selection for farmers or breeders in drought affected areas relative to their cultivation or breeding programs respectively.

**Keywords:** Drought performance, gas exchange, grain sorghum, millet, water use efficiency

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## **Influence of Water Deficit on Digestibility of Soybean Organs**

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The soybean (*Glycine max* L. MERR.) was introduced to North America in the mid 1800s and was initially promoted as a forage crop. By the late 1940s, the focus had shifted almost entirely from forage to soybean grain production. However, the seeds as well as the entire plant is employed as feed stuff in animal production. The nutritive value of forage crops is a function of the composition of the individual plant components, their relative contribution to total plant dry weight and the content of nutrients. Soybeans are grown in many areas where rainfall is marginal or where drought stress is intermittent. Effects of drought on yield are known, but unknown is the impact of soil moisture deficits and the nutritive value of soybean plant organs. The influence of a 8-10 day water deficit (wd), on yield parameters was examined in 2 pot experiments in growth chambers (experiment A: wd at flowering, genotype Gieso; experiment B: wd at seed filling phase, genotype PI 416937 and Hutcheson). The dry matter (DM) and nitrogen (N) degradability of leaves, pod walls and crude seeds were estimated using the nylon bag technique (experiment A), and the in vitro gas production of crude seeds (experiment B). All yield parameters were significantly lowered by water deficit, whereas the N digestibility of pod walls and seeds, and the DM digestibility of seeds was increased. The in vitro measurements showed that seeds growth of PI 416937 which was decreased by water deficit led to a reduction of gas production, energy content and digestibility of organic matter. Such effects of water deficit were not detected in seeds of Hutcheson. This should be taken into consideration in calculating the ratio of optimum energy to nutrient utilisation, if such interactions between water deficit and genotypes prove to be generally true.

**Keywords:** Soybeans, water deficit, yield quality

## **Future Potentials for Food Production & Wastewater Treatment in Havana's Urban Vegetable Gardens**

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The objectives of this study were to describe Havana's urban vegetable production, to analyse production constraints, and to explore the potential of ecological sanitation techniques (primarily greywater wetlands) for providing water, organic matter and nutrients. Onsite interviews were conducted at 10 gardens. The gardens were selected to include different forms of ownership, localities, and management practices. Additional information was collected from other stakeholders such as government officials, NGO representatives, and university researchers. Onsite measurements and discussions with stakeholders provided data on the supply of water and organic matter. Supply of nitrogen, phosphorous, and potassium was addressed through an experimental comparison of the nutrient uptake of lettuce plants grown in the gardens with a control group of plants provided with sufficient nutrients. Results showed that water supply was adequate in 7 of the 10 gardens, but there was a deficiency of nutrients and organic matter in all gardens. The average total nitrogen concentration of lettuce plants grown in the gardens was 2.0–2.3 % compared to a target value of about 5.0 % as determined in the control group of plants and from literature. Potassium and phosphorous deficiencies were less severe. This was due to a shortage of organic and inorganic fertilisers in the market and limited recycling through, for example, locally composted organic waste. Greywater wetlands would not relieve the deficiency of nutrients and organic matter. It is recommended to examine other ecological sanitation techniques, for example blackwater utilisation and improved composting of organic household waste. Further research and development involving gardeners and other stakeholders is needed particularly regarding blackwater utilisation.

**Keywords:** Ecological sanitation techniques, greywater wetlands, nutrient supply, organic matter supply, urban vegetable production, water supply

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## Relationships Between Evapo-transpiration Efficiency and Various Plant Characteristics of Different Cowpea Genotypes

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Cowpea (*Vigna unguiculata* L. WALPERS) is an important source of food for hundreds of millions of people in the developing world and generally considered to be more drought tolerant than most other legumes. Nevertheless, drought is a major production constraint. Studies were conducted to determine the relationships between evapo-transpiration efficiency (ETE) and morpho-physiological characteristics [transpiration (E) and assimilation (A) rates, the ratios E/A and A/E, above-ground biomass, leaf area (LA), specific leaf area (SLA) and specific leaf weight (SLW)]. These studies were performed on 7 cowpea genotypes during the vegetative phase under well-watered conditions in the greenhouse. On two different occasions (43 and 65 days after planting, DAP) these characteristics were monitored, measured and analysed.

For all genotypes on both sampling dates significant positive correlations ( $p = 0.05$ ) were found between ETE and dry matter of leaves, main stem, total shoot biomass; between E and total shoot dry matter; between E and A and branch biomass; and among LA, dry matter of leaves, main stem, branches and total shoot biomass. Negative significant correlations were observed between the following groups: ETE and SLA; A and E/A; and LA and E/A. The performance of the 7 genotypes regarding most of the mentioned characteristics also displayed significant differences, except A, A/E and branch dry matter production 43 DAP. Non-significant differences between the genotypes could be established 65 DAP for SLA, leaf DM, main stem DM, E/A and A/E.

Despite progress in the last thirty years in using morphological and physiological properties as tools for management and breeding of crops, some contradictions still exist. In the case of cowpea, this study revealed some of the relationships between ETE and some morpho-physiological properties. The hypothesis that correlations exist between ETE and A/E could not be established.

**Keywords:** Cowpea, evapo-transpiration efficiency, gas exchange, plant characteristics

## Fertigation of Onion Crops by Using Surface Irrigation in Sudan

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Onion (*Allium cepa* L.) belongs to the most cultivated vegetable crops in Sudan. Farmers grow it mainly in the Gezira area, using Nile water for surface irrigation, and nitrogen as mineral fertiliser. Due to high pH values of Gezira Vertisols (7.5–8), a lot of the applied nitrogen gets lost by NH<sub>3</sub>-volatilisation, and also due to run off and leaching as a consequence of irregular irrigation. To minimise these nitrogen losses, we should develop better systems, to establish an ecological and sustainable agriculture. Therefore, we carried out field experiments using soluble fertiliser (same amount of N as in the traditional system) together with the irrigation water. We compared this “fertigation” system with the traditional separate system of irrigation and fertiliser broadcasting, using three steps of nitrogen (0 N, 1 N and 2 N, 1 N = 43 kg N ha<sup>-1</sup>) on the Gezira research farm, near Wad Medani, in two seasons, in a complete randomised block design with 4 replicates. In other parts of the world, fertigation is common either using sprinkler or drip irrigation. As these irrigation methods are not available in Sudan, we used the existing surface irrigation, but with a special device for calculation of the exact amount of soluble fertiliser and water needed for each sub-plot. At harvest, weight and number of large, medium, small, double and rotten onions were recorded.

Results indicate that added nitrogen in any form increased the yield significantly compared to the 0 N-treatment. In the first season, compared to “normal” irrigation with fertiliser broadcasting, fertigation resulted in higher weight and number of large, medium and double onions. Under these conditions, 1 N gave the highest yield of the large and medium ones. In the second season, fertigation resulted in higher weight and number of small, and in higher weight of medium and double onions.

It can be concluded that there are beneficial effects of the fertigation system via surface irrigation on onion production in the Gezira area. Further trials should show whether the proposed system can be useful also for other crops.

**Keywords:** Fertigation, nitrogen, onion, Sudan

## **Development of Water Balance Model of Lake Ziway Watershed in Ethiopia**

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The study area is part of the Ethiopian Rift Valley that is located in central Ethiopia. It is important sites in Ethiopian Rift from a water resources development point of view. Water and land resource development plans were implemented with short-time interests, though it was understood that the recent increased abstraction of water from lakes and rivers caused some changes in the lacustrine environment. Some of the lakes have reduced in size (ZINABU, 1989) and changes in the chemistry of the lakes have been observed, but it is largely unknown whether the ecosystem has been affected (HALCROW, 1989).

Future uncontrolled abstraction of water will inevitably change the hydrologic balance of the lakes and the ecology of the lacustrine environment. Knowledge of the water balance assists the prediction of the consequences of artificial changes in the regime of streams, lakes, and ground-water basins. The objective of the study is to understand the hydrology of lake Ziway. This requires assessment of water balance components like rainfall, evapotranspiration, runoff and etc, and their interactions. Evapotranspiration was estimated using Modified Penman Method and was compared with the data from evaporation pan. Average rainfall for the area was estimated using Isohyetal Method. The model was developed using the values from each water balance component. Besides analysis of the river flow data from gauging station at Meki town was made and the result has shown that the river will actually dry up at some time during the period December to March. Moreover, the flows that do occur during this period can be particularly low and variable. Based on this river discharge analysis of Meki there can be no prospect for year-round, large-scale irrigation in the Meki catchment based on run-of-river flows. The difference between inflow and outflow is found to be -45.24 mcm. This again indicates groundwater inflow. From the analysis it was found that 85 % of the water coming to lake Ziway goes as evaporation, for this reason it is recommendable to look for a technology that could be economically used to reduce evaporation and make available the water for irrigation and other uses.

**Keywords:** Ethiopia, evapotranspiration, infiltration, rainfall, riftvally lake, run-off

## Appraisal of Drinking Water Resources of the Mekong Delta, Vietnam

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Within the last few years there was a rapid economical growth in the Mekong Delta, Vietnam. An increase of domestic and industrial water demand as well as an increase of ground and surface water pollution was observed. Thus, especially in the rural areas water supply is a problem of increasing significance. Surface water for instance which is often used for drinking water purposes is highly polluted by agro-chemicals and other organic pollutants (e.g. inflow of untreated waste water). Implementation of decentralised water management systems in rural areas are the main topic of the interdisciplinary SANSED-Project.

One part of the SANSED-Project is the depiction and appraisal of the potential drinking-water resources. Ground water, rain water and surface water are used for drinking water purposes. The main objective of this research is the development of a method to identify problems related to the water supply situation.

Therefore it is necessary to evaluate the potential drinking water sources. Field investigations regarding yield, quality and usability as well as demand and actual use of ground water, surface water and rainwater are carried out at two selected study sites in the Mekong Delta. Hydrogeological methods as well as self-developed methods to evaluate the technical conditions of water supply facilities (wells, pumps, etc.) are developed and adapted to the local boundary conditions. Additionally water samples were taken and analysed on chemical and microbiological parameters.

Besides field work at those two study sites investigations for a surrounding area were carried out. Data on hydrogeological, hydrological and climate are collected at local authorities and institutions to get a better understanding of the system and to identify problems on a larger scale. Therefore it is possible to categorise and identify “zones of similar conditions”. Based upon those results a sustainable water supply concept including technical solutions (e.g. water treatment) should be developed.

**Keywords:** Applied methods, groundwater, Mekong Delta, rural, surfacewater, Vietnam, water supply

## Potentials and Constraints of Irrigation Experiments with Farmer Cooperation in a Water-scarce Area of Northwest Syria

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Groundwater is a scarce resource in Khanasser valley, northwest Syria. Its use is limited by groundwater yield and salinity. About 50 per cent of the total groundwater abstractions are applied to wheat, predominantly bread wheat (*Triticum aestivum* L.) by sprinkler irrigation (average EC: 5.8 dS/m) and basin irrigation (average EC: 10.0 dS/m). In order to investigate the potential for increasing groundwater use efficiency in Khanasser valley or similar dry areas, the effects of different application rates on yield and income of wheat were evaluated. Two experiments were conceived, one using sprinkler irrigation (Trial A), the other basin irrigation (Trial B). Each trial with 4 replications included the following treatments: Full supplementary irrigation, farmers' treatment and rainfed control. These were compared with deficit irrigation (Trial A) and leaching (Trial B). The experiment was managed in cooperation with the farmers. Soil salinity was recorded before and after the experiments; soil moisture was monitored with the neutron probe at regular intervals. Due to high evaporation rates in the spring, the farmers (Trial A) had difficulties to bring the soil moisture back to field capacity as this delayed their irrigation schedule. The use of different application rates in the basins (Trial B) was constrained by insufficient land levelling. Frost in early April 2004 (-7 °C) severely damaged the emerged ears in one field, which had been planted 10 days earlier than the rest. Apart from this specific effect, yield differences between the sites were due to water applications, the salinity of the irrigation water and the irrigation method. The experimental approach and the results were discussed with the farmers and conclusions were drawn for the design of consecutive trials.

**Keywords:** Dry areas, groundwater resources, soil salinity, supplementary irrigation, Syria

## Correction Factors for TDR-soil Moisture Measurements Within the Tree's Root Zones

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Irrigation systems has been established all over the world to secure crop production and therefore cash income during dry seasons. But water scarcity prompts farmers to budget water in order to avoid a total crop failure and loss of their major source of income. The less water, the higher the potential for conflicts about water.

In order to investigate the efficiency of irrigation systems, the root zone of mango trees has been equipped with TDR (Time Domain Reflectometry) soil moisture detection devices in an orchard, close to Chiang Mai, Northern Thailand. The TDR-technique has been adapted to detect the velocity, an electromagnetic wave is spreading within a medium. Waves' velocity is only dependent on relative permittivity  $\epsilon_r$  besides magnetic permeability  $m_r$  of soil. Magnetic permeability of most soils can be set to 1, therefore the wave-velocity is only dependent on the relative permittivity. Permittivity of dry, porous material ( $\epsilon_r < 5$ ) is significantly lower than the one of water ( $\epsilon_r = 81$ ). So transit time and soil moisture are directly related, which results in soil moisture content.

The trial is meant to control the soil moisture within the relevant root-zone in order to optimise irrigation efficiency with different irrigation-designs and –scenarios. Simultaneously the TDR-technique is combined with a high resolution soil-temperature recording of the portrayed root-zone. The combination of the data-sets of irrigation amount, weather data, soil moisture and soil temperature draws a clear picture of ideal irrigation conditions. The TDR-signal is effected by soil temperature, therefore it is additionally verified by laboratory drying of soil samples. The combined information of soil samples, soil-temperature, soil moisture and soil density creates a temperature correction factor for TDR-measurements, which enables to improve TDR-measurement's accuracy in field trials with alternating soil temperatures.

**Keywords:** Correction factors, irrigation, Mango, soil temperature, Thailand, Time Domain Reflectometry (TDR)

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# Subsession 5c: Rural Energy Supply and Strategies for Biomass Production

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## Controls of Woodfuel Supply and its Impact on Biodiversity Conservation

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Wood based energy is the most important energy source for a majority of households in developing countries. In contrast, however, woodfuel consumption is also a major contributor to total wood removal and, hence, deforestation. In response to this problem, forest resources in developing countries are increasingly managed through a control and command system meaning that without permits obtained from the law enforcing authorities, the extractive use of resources such as fuelwood and charcoal becomes illegal.

This paper applies a theoretical model that was developed for the illegal trade of narcotics to analyse whether a command and control system of woodfuel collection can be successful in promoting natural resource conservation. The results of this model demonstrate clearly that increasing enforcement and seizure of illegally produced fuelwood and charcoal leads to a simultaneous increase in the production of these products and, thus, contributes even more to deforestation. Furthermore, it is shown that such a system increases market prices, which can be attributed to a low price elasticity of demand on the side of the consumer due to a lack of appropriate substitutes. This has a negative impact on the economic situation of the poorest households and, thus, this policy approach does not contribute to poverty alleviation. The implications of this model are discussed with special emphasis on the inelastic demand of woodfuel in developing countries, showing that in the short- to medium-term, an increase in woodfuel consumption must be expected.

Based on the results of this model — and knowing that command and control policy approaches frequently lead to extra-legal, rent-seeking behaviour on the side of the law enforcing authority — it is proposed to legalise woodfuel production and marketing. Instead, policy intervention should focus on providing an appropriate institutional environment instigating tree-planting activities at the household level. Lastly, the use of wood as a source of energy is examined with special reference to the objectives of poverty alleviation.

The theoretical model is complemented by statistical analyses using data from Madagascar.

**Keywords:** Biodiversity conservation, deforestation, illegal trade, poverty, woodfuel consumption

## Population Growth and Deforestation in the Volta River Basin of Ghana — Integration of Remote Sensing and Census Data

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The Volta River basin in Ghana, which covers about 160,000 square kilometres, is one of the areas experiencing rapid deforestation in West Africa. According to the Food and Agriculture Organisation, the annual rate of deforestation in Ghana was 1.72 % per annum or 120,000 hectares each year within the period 1990–2000 (FAO, 2000). The impact of deforestation is widespread, affecting the livelihoods of the local people, disrupting important environmental functions and severely disturbing the biological integrity of the original forest ecosystem. This paper relates the trends and patterns of population (measured by population density) in four sub-basins of the Volta river basin in Ghana, namely, White Volta, Black Volta, Main Volta and Daka to forest cover. It begins by assessing the amount of forest available in 1990 and 2000 in the respective districts, and concludes with an assessment of the relationship between population density and forest cover in 1990 and 2000. Predictions regarding forest cover that might be lost as a result of changes in population density in the sub-basins in 2000 was computed for the year 2010 based on a simple regression model and demographic projections. The forest cover predicted for 2010 was matched with actual forest cover in 2000, determined from remote sensing analysis of satellite images. A forest availability status table was generated to give an indication of the amount of forest cover that would be available for the districts in the sub-basins in the year 2010. Predictions show that about 20 % and 25 % of all sub-basins within the Black Volta and Daka sub-basins, respectively, would experience deforestation as a result of increase in population. Finally, other indirect demographic factors, namely, the farming systems, practices and inputs used, type of crops grown, household consumption patterns, source of fuelwood as energy for cooking, extensification of agricultural lands, and general living conditions were all shown as indirect demographic reasons for deforestation.

**Keywords:** Africa, forest cover, Ghana, population, river basins

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## **Socio-economics, Investment Analysis and Economics of Tree-crop Interactions — A Case of Agroforestry in Rainfed Tropics**

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Agro-forestry has emerged as one of the prominent integrated farming approaches as it reduces the dependence on fast depleting forest stock for various biomass needs in developing countries. It can support short term as well as long-term goals of conservation and can provide local and global benefits. But to assess the efficacy and effectiveness of agroforestry, it is imperative to assess its impact on the cropping pattern, household employment and income of farmers apart from assessing its role in meeting biomass needs like fodder, fuel and timber. This paper shows the relative profitability as a major dimension of agroforestry practice. A probe into socio-economic factors that hinders or encourages the agroforestry is also carried out. Another dimension of this system is tree crop interactions, which can be synergistic or harmful but the success of any intercropping system depends on the balance of positive and negative interactions between the components. Quantification of these interactions in economic terms is attempted here. Technical, legal, marketing and financial needs of the farmers and their preferences for tree species for further planting were documented. This study was conducted in Karnataka State in South India. The results points out that there is a net income gain from cultivating trees on bunds of dry area crops even though a reduction in net income from the crops alone is observed. A discriminant function analysis of the socio-economic factors revealed that the land area, availability of subsidiary income and level of education were the most important factors that discriminated the practioners and non-practioners of agroforestry.

**Keywords:** Agroforestry, socio-economics, tree-crop interactions

## **Polyethylene Biodigesters as Energy-providing Sources and Integrated Farming Systems of Rural Household in Cambodia**

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Integrated farming system, a form of conditional exploitation historically and durably, is adapted to the productive dynamics of agro-ecology and the social demands. However, Cambodian agricultural indices are showing a non-sustainable sound. Forestland was degraded from 73 % to 66 % whereas the permanent pastures were enlarged from 3 % to 8 % of total land in last decade. Integrated farming system among farmers to ensure the sustainable agriculture, therefore, is encouraged. The objective of this paper is to evaluate the role of polyethylene biodigester as a unit of system and gas producer for cooking. Particularly, it is aimed to assess its effects on Cambodian smallholders and to identify awareness and problems associated with this technology. Data were collected from 50 households in various regions. Digesters are 10.2 m in length, 5.1 cubic metres in volume and cost 25 USD. By loaded 15 kg of manure, biodigester produced 1000 l of gas daily, 50 % are methane. Farmers, especially children and woman can save time in finding (4.4 h/day) and buying fire wood (6.5 USD/month). Biodigesters play roles in raising the disputation of farmer in the community mainly by reduce the problem of wood-finding competitive (80 % response), provide more time in other activities (65 % response) and home-member healthcare (70 % response). Farmers were aware with the role of digesters in farming system. The development of a manure-based duckweed production system and its utilisation as livestock feed is essential for sustainable livestock farming. Aquaculture-biodigester were proposed to introduce to farmers. It is found positive effects of effluent from digester on crop yield especially vegetable and cassava as biofertiliser. Water-born and food-born diseases were reduced. Household incomes were generated and alleviate the problem of energy shortage. However, only few farmers in the community used biogas in practice due mainly to the high cost of the digesters, difficulty in installing and in getting spare parts. The biogas programs developed only under substantial support from projects. Promote the low-cost biodigester technology; therefore, is aiming at reducing the production cost by using local materials and simplifying its operation.

**Keywords:** Biodigester, energy source, integrated farming system

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## Effect of Different Tapping Tools and Different Tapping Positions on 'Talh Gum' Yield of *Acacia seyal* var. *seyal* in South Kordofan, Sudan

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Sudan is well known for its large 'Gum Arabic' production. More than 80 % of the total 'Gum Arabic' worldwide is collected in the 'Gum Belt' of Sudan. The gum is mainly obtained from *Acacia senegal* ('Hashab'). However, there also exists other gum producing trees. One example is *Acacia seyal* var. *seyal* ('Talh') which is known to produce 'Talh Gum'. Little information is available about the tapping possibilities of *A. seyal* var. *seyal* for gum production.

Two experiments were conducted to investigate the effect of different tapping techniques on gum yield of *A. seyal* var. *seyal*. The experiments were conducted at Umfakarin forest reserve (South Kordofan). Both experimental designs adopted were randomised complete block designs with three replications. Each block was divided into four sub-plots and each sub-plot represented an experimental unit. Unit size was 10 × 10 m with an average of five trees (500 trees/ha). The trees were tapped on the 1st of November and gum was collected four times (1<sup>st</sup> Dec., 1<sup>st</sup> Jan., 1<sup>st</sup> Feb. and 1<sup>st</sup> March).

In the first experiment, four different tapping tools ('Makmak', 'Axe', 'Mofar' and 'Sonkey') were used. In the second experiment, the trees were tapped on four different positions (low stem: 50 cm, middle stem: 150 cm, high stem: 200 cm and branches) using the 'Makmak'. The yield of each tree was determined by weighing the gum after each collection. The results of the first experiment clearly indicate that the 'Makmak' was the best tapping tool. The total gum yield was 428 g/tree. The tapping with 'Axe', 'Mofar' and 'Sonkey' caused a total gum yield of 177, 169 and 104 g/tree, respectively.

In the second experiment, the middle stem tapping produced the highest gum yield with a total yield of 275 g/tree. The low stem tapping, the high stem tapping and the branch tapping gave a yield of 204, 117 and 162 g/tree, respectively.

In conclusion, the experiments show that the 'Makmak' is the best tapping tool and the middle stem the best tapping position for a high 'Talh Gum' yield.

**Keywords:** *Acacia senegal*, Hashab, non wood forest product, Sudan, Talh Gum, tapping

## **Forest Plantation Establishment on Private Land in the Savannah Zone of Ghana — A Problem Oriented Research Project**

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The project area is located in the Ashanti Region of Ghana/West Africa in the transition zone of the moist semi deciduous forest and tropical savannah zone. Main land use in this region is subsistence agriculture with large fallow areas. As an alternative land use, forest plantations are under development by the Ghanaian wood processing company DuPaul Wood Treatment Ltd.. Labourers from the surrounding villages are employed as permanent or casual plantation workers.

Within their three forest plantation projects of approximately 6000 ha, DuPaul offers a 164 ha area (referred to as Papasi Plantation) – which is mainly planted with Teak (*Tectona grandis*) – for research purposes. In return, the company expects consultations to improve the management for sustainable timber and pole production with exotic and native tree species. In a first research approach, the Papasi Plantation was assessed in terms of vegetation classification, timber resources (in qualitative and quantitative terms) and soil and site conditions. A permanent sampling plot system was established to enable long-term monitoring of stand dynamics including observation of stand response to silvicultural treatments. Site conditions are ideally suited for Teak and some stands show exceptionally good growth performances. However, poor weed management and a lack of fire control and silvicultural management led to high mortality and poor growth performance of some stands, resulting in relative low overall growth averages. In a second step, a social baseline study was carried out in the surrounding villages and identified landowner conflicts between some villagers and DuPaul, which could be one reason for the fire damages. However, the study also revealed a general interest for a collaboration in agroforestry on DuPaul land on both sides.

Thirdly, a silvicultural management concept was elaborated and an improved integration of the rural population into DuPaul's forest plantation projects is already initiated. If landowner conflicts can be solved, the development of forest plantations can contribute significantly to the economic income of rural households while environmental benefits provide long-term opportunities for sustainable development of the region.

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**Keywords:** Forest plantation, Ghana, growth, rural development, silviculture, Teak

## Tree Volume and Taper Function for *Cordia alliodora* in Agroforestry System, Protected Forest Sumaco

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The Protected Forest Sumaco is characterised by extensive areas of secondary forests. It provides a buffer zone for the National Park Sumaco-Napo-Galeras at an altitude of 1,160 m above sea level and with a precipitation of 4,000 mm year<sup>-1</sup>. Adequate management of secondary forest in this protected area requires basic data about growth and volume–dependent regeneration of Laurel in agroforestry systems. Consequently, accurate and flexible methods are required to estimate stand and tree growth and yield. Since the introduction of regression methods into forestry, it has been common practice to select models for growth and yield based on diagnostic and model selection criteria, and to estimate equation coefficients for specific data. Mathematical properties, such as algebraic consistency, have been applied to improve model specification. A system of equations is called algebraically (also referred to as mathematically) consistent if one equation in the system can be expressed in terms of the other equation(s). For example, if an individual tree volume equation can be expressed in terms of a taper function, or vice versa, the system of equations is algebraically consistent. The objective of this study was to derive a system of equations in order to determine the volume and taper function that is both, mathematically and numerically, consistent for *Cordia alliodora*. For the parameterisation of the total volume and taper function 77 trees were taken. Altogether 308 observations were used, such as DBH, the diameter at 2, 4, 6, 8 meters and the total height. The volume was estimated with the Smalian Formula for five sections. The two models used in this research were validated, using 44 independent trees from the neighbouring community of Wawa Sumaco.

**Keywords:** Dimensional analysis, Ecuador, Laurel, local management system, mathematical consistent

## **Non-timber Forest Products — Opportunities and Constraints for Poverty Reduction in the Nuba Mountains, South Kordofan, Sudan**

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This paper examines the potentials and constraints of non-timber forest products (NTFPs) to poverty reduction in South Kordofan State, Sudan. The main objectives of the study are to emphasise the variety of non-timber producing trees and shrubs species found in the area, to describe their potential contribution to local inhabitants health and wealth, and to indicate major constraints to promoting their domestication and planting for non-timber forest products. Drawing on a study of four provinces in south Kordofan State, the findings confirms that these tree species contribute significantly to the diet and income of the rural inhabitants. The area is naturally endowed with a multiplicity of trees and shrub species commonly exploited for a variety of uses such as food, medicine, fodder, and income generation. These trees and shrubs have a substantial impact on the productivity and sustainability of production systems in the area. The study revealed that most of these species are badly exploited and the extraction of their products is so primitive and will lead to the endangerment of the species. These exploitation methods coupled with poor managements of naturally growing trees in absence of tree planting strongly threaten the sustainability of production and diversity. It is recommended that NTFPs trees and shrub should be conserved and improved and given high research priority in order to sustain productivity and hence food security and income. Research should focus on appropriate extraction methods, propagation and planting techniques, processing and marketing. Furthermore, the local communities should be involved at early stages in domestication programs.

**Keywords:** Domestication, non-timber forest products, Nuba Mountains, poverty reduction, South Kordofan, Sudan

## **Economic Evaluation of Commercial Value of Timber and Non-timber Forest Products of *Cordia dodecandra* in Southern Mexico**

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In Mexico, forests and wildlands have enormous social value for rural communities. Approximately, 18 millions people live in forest region. They are ethnically diverse and, for the most part, poor. Poverty is concentrated in the heavily forested southern states (Yucatán Peninsula). The Mayan peasant farming families of the Yucatán Peninsula in south east Mexico have traditionally depended upon a “Slash-and-burn” system of staple food production. The land they work is collectively owned. This system is called ejido. Eighty percent of forest lands belong to ejidatarios and indigenous people. The communal forest in Yucatan has been overexploited for many decades. Deforestation took place in order to establish henequen plantations, provide grazing areas for extensive livestock management, for tropical wood exploitation and as part of national resettlement and agricultural modernisation programmes. Poverty amongst campesino families in Yucatán increases hand in hand with natural resource depletion. One of the most common strategies proposed in recent years for addressing environmental degradation and income generation in rural areas of the tropics is agroforestry. The Mexican Department of Forestry (CONAFOR) is now encouraging research programs on the reforestation with native tree species in order to increase the farmer’s income and reduce the reforestation and soil degradation. One potential specie for reforestation is the multi-purpose tree *Cordia dodecandra* (Ciricote) which originates from the Yucatán Peninsula. It produces fruits and valuable timber. Because of the high economic value of its timber, in some cases more than the value of *Swietenia macrophylla* (Mahogany), *Cordia dodecandra* is a endangered species due to over exploitation. Few natural stands of *Cordia dodecandra* are scattered in the primary and secondary forests in the Southern Peninsula, in the State of Quintana Roo and Campeche. Planting *Cordia dodecandra* in agro-forestry scheme for the purpose of timber or fruits production might be a promising alternative for farmers all over the Peninsula. Comparison between the commercial value of timber and non-timber forest products (fruits) of *Cordia dodecandra* were carried out with the Net Present Value (NPV) analysis due to the farmer has to choose between timber and fruit production.

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**Keywords:** Economic evaluation, non-timber forest products, timber, Yucatan Peninsula

## Effect of Time and Intensity of Tapping on ‘Talh Gum’ Yield of *Acacia seyal* var. *seyal* in South Kordofan, Sudan

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*Acacia seyal* var. *seyal* locally known as ‘Talh’ is the most widespread *Acacia* species in the Sudan. It is an important multipurpose tree providing firewood, building materials and fodder. The species also produces gum, which is collected in some areas. However, little information is available about the tapping possibilities of *A. seyal* var. *seyal* for gum production.

An experiment was set up to investigate the effect of tapping time and tapping intensity on gum yield of *A. seyal* var. *seyal*. The experiment was conducted at Umfakarin forest reserve (South Kordofan). The experimental design adopted was a 2-factor randomised complete block design with three replications. The first factor was time of tapping, which was tested in three levels (1<sup>st</sup> November, 15<sup>th</sup> November and 1<sup>st</sup> December). The second factor was tapping intensity, which was tested in four levels (2, 4, 6 and 8 branches). Each block was divided in four sub-plots and each sub-plot represent an experimental unit. Unit size was 10 × 10 m with an average of five trees (500 trees/ha). The first collection of gum took place 30 days after the tapping, followed by three further collections in an interval of 30 days. The yield of each tree was determined by weighing the gum after each collection.

The results clearly shows that *A. seyal* var. *seyal* produces the highest gum yield when it was tapped on the 1<sup>st</sup> of November. The total gum yield of the 2, 4, 6 and 8 branch tapping was 203, 179, 184 and 177 g/tree, respectively. However, when trees were tapped on the 1<sup>st</sup> Dec. the total gum yield per tree of the 2, 4, 6 and 8 branches decreased by 41 %, 34 %, 51 % and 43 %, respectively. The tapping intensity did not show a clear effect on the yield production of the *A. seyal* var. *seyal* trees.

In conclusion, the result indicate that the tapping time had a stronger influence on the ‘Talh Gum’ yield rather than the amount of tapped branches.

**Keywords:** *Acacia senegal*, Hashab, non wood forest product, Sudan, Talh Gum, tapping

# Subsession 5d: Exploring and Sustaining Aquatic Systems

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## Applying Integrated Natural Resources Management to Sustain Coastal Fisheries

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Vietnam's coastal waters feature high bio-diversity and rich fishery resources. The selected study site, Nha Phu Lagoon is characterised by massive degradation of coastal fishery resources. As a result rural livelihoods in coastal communities are threatened. Since households in these communities not only depend on coastal resources but also have various other forms of income outside the fishery sector a multi-sectoral approach is necessary. A multi-sectoral approach not only addresses all these issues but also takes account of the complexity and diversity of the resource system and its users. Integrated Natural Resource Management (INRM) is one multi-sectoral research approach that aims to develop innovative and flexible management forms to manage natural resources in a more sustainable way. The applied INRM-approach is characterised through strong interdisciplinary and participation. Interdisciplinary means that socio-economic and institutional aspects, e.g. resource-user groups and existing legal arrangements are combined with biological as well as production system aspects, e.g. stock assessment as well as aquaculture or gear-fishing techniques. The focus lies on the identification of multiple equal important starting points to improve natural resources. Through the integration of biological and socioeconomic aspects, complex problems were identified within the coastal fishery resource system and its users during a six months investigation period. In group-discussions and interviews reasons for the destruction of fishery resources were gathered, e.g. trawling, population increase and pollution from shrimp ponds. This information was then shared with participants, which led to new insights as well as alternative resource management strategies. Illegal trawl-fishermen for example were said to be extremely poor and therefore needed to be treated with great tolerance despite their negative impacts on coastal fishery resources. But during follow-up visits it was discovered that illegal fishermen often belonged to middle-class households around Nha Phu Lagoon and that lax enforcement rather encouraged illegal fishing and punished those fishermen using traditional fishing methods. The participatory approach induced awareness-building and strengthened local decision-making structures. Considering sociological, political, economic and biological elements in the coastal fishery resource system could lead to more sustainable resource management in the future.

**Keywords:** Aquatic resources, Coastal fisheries, integrated natural resources management, Vietnam

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## The Artisanal Fisheries of Lake Albert and the Problem of Overfishing

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With lakes, rivers and swamps covering nearly 20 % of its land surface, Uganda has an important fisheries sector. Lake Albert contributes significantly to Uganda's fish production and ranks third behind Lakes Victoria and Kyoga. The population at the lakeshores lives almost exclusively from fishing and fishmongering. However, like the other large inland water bodies of East Africa Lake Albert is heavily overfished.

The few existing studies on fisheries in Uganda predominantly look at Lake Victoria and at fisheries technological and biological issues. This study however, sheds light on the socioeconomic aspects of the artisanal fisheries at Lake Albert and the determinants of the overfishing of the lake.

The results of the study show that the problem of overfishing cannot be explained with a simple causal chain, but that it is a result of a complex set of economical, socio-cultural and political factors. Firstly, factors such as widespread poverty, a lack of economic alternatives or the high cost of appropriate fishing gears lead to an overexploitation of the open access fisheries. Secondly, collective action to solve the problem is inhibited by a lack of problem awareness and the conflicts of interest between rich and poor fishermen as well as between indigenous people and migrants. Moreover, on the political level the lack of enforcement of existing fisheries laws is a problem.

In the long term, the sustainable use of the fish stocks and a sustainable basis for nutrition, employment and income are mutually dependent. In the short term, however, there will be conflict, since any measure for the recovery of the fish stocks will immediately lead to a reduction in income. It is therefore recommended that any measures for the conservation and sustainable use of the fisheries resources should be accompanied by an integrated development. Moreover the population of the fishing villages should participate in the development and the implementation of the measures in order to ensure their success.

**Keywords:** Fisheries, natural resource management, overfishing, rural development, tragedy of the commons, Uganda

## Tropical Freshwater Fishes — Potential for Aquaculture Development and Ecophysiological Research

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About 50 % of all known vertebrates are fishes. Of the estimated number of approximately 30 000 fishes nearly 50 % comprise freshwater species, most of which are tropical freshwater fishes. Due to the high demand for animal protein in the tropics the aquaculture of tropical freshwater fishes has developed tremendously over the last decades. However, only a limited number of tropical freshwater species has been used up to now for aquaculture purposes. One reason for this is the lack of knowledge concerning biology and in particular reproduction in these species. The aim of our comparative study is to increase the knowledge on the reproduction - with preference on cyclical reproduction - of those taxa of tropical freshwater fishes comprising many economically important species.

In the framework of cyclical reproduction we study the influence of the variation of three environmental factors (decreasing conductivity, increasing water level, imitation of rain) on the maturation of gonads and finally spawning in the African knife-fish *Xenomystus nigri*, on one silurid catfish, *Kryptopterus bicirrhis*, one schilbeid catfish, *Eutropiellus vandenweyeri* and two species of mochokid catfishes, *Synodontis nigrita* and *S. nigriventris*.

This paper discusses both aspects, **a)** the potential of tropical freshwater fishes for aquaculture development and **b)** ecophysiological research, with special emphasis to African fishes.

**Keywords:** Aquaculture development, cyclical reproduction, environmental factors, tropical freshwater fishes

## The Free Living Nematode *Panagrellus redivivus* as an Alternative Live Food to *Artemia* in the Nutrition of Larvae of the Pacific White Shrimp, *Litopenaeus vannamei*

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During the last decade global aquaculture production doubled and thus represents an important source of income and food. Due to the dependence of the early larval stages on live food, production of stocking material still represents a crucial bottleneck in the full commercialisation of many marine finfish and crustacean species. The free living soil nematode *Panagrellus redivivus* is well known to be an excellent food source for first feeding fish larvae. It represents an alternative to the highly expensive *Artemia*, which is commonly used. The lack of a proper method for mass production of *P. redivivus* has prevented its wider use in commercial hatcheries. A new cultivation method allows the production of a sufficient quantity of nematodes to deliver a standardised and permanent available live food of high quality, throughout the larval rearing period. This method consists of autoclavable plastic bags filled with sponges soaked with growing medium. The bags are inoculated with *Saccharomyces cerevisiae*, kept aerated and humid during the incubation time. Depending on the medium used, the nutritional characteristics of *P. redivivus* can be altered to a certain degree, to fit larval demands.

The experiments were carried out at the CIAD (Centro de Investigación en Alimentación y Desarrollo), Mexico. Several feeding regimes were established to prove the quality of the mass produced *P. redivivus* for larvae of *Litopenaeus vannamei*, the pacific white shrimp. Two different nematode treatments were compared to a no feed group and a control group which was fed with *Artemia*. All treatments had an additional algal co-feed and were run in five replicates. *P. redivivus* was cultured on two different media (wheat/corn flour and oat flour) to compare these for their suitability as high quality live food for the larvae. At the end of trial survival rate, body length, dry weight, developmental stage and protein content of the shrimp were evaluated.

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Shrimp fed nematodes grown on wheat/corn medium reached the post larval stage earlier than those from other treatments. The nematode treatments showed promising results which emphasize further research on topics like different growing media or enrichment methods for essential fatty acids.

**Keywords:** Alternative live food, *Litopenaeus vannamei*, pacific white shrimp, *Panagrellus redivivus*

## Plant Extracts for the Treatment of Ichthyophthiriasis in Fish

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The ciliate *Ichthyophthirius multifiliis* is one of the most pathogenic parasites of fish, and it constitutes a major disease problem in aquaculture. The most effective treatment of *I. multifiliis* was achieved by use of malachite green, but meanwhile its use for the treatment of disease in food fish has been discouraged due to its potential mutagenic and teratogenic properties. Recently, there have been increased research activities into the utilisation of traditional plant-based medicines to control bacterial and parasitic infections in human and animal medicine. However, the use of medical plant extracts for the treatment of parasitic diseases in fish has rarely been reported.

In the present study, the effects of the crude methanolic extract of leaves of *Mucuna pruriens* and the petroleum ether extract of seeds of *Carica papaya* against *I. multifiliis* were investigated. Goldfish (*Carassius auratus auratus*) infected with the parasites were immersed for 72 h in baths with *M. pruriens* extract, and for 96 h in baths with *C. papaya* extract. There was a 90 % reduction in numbers of *I. multifiliis* on fish in 200 mg l<sup>-1</sup> baths of each plant extract compared to untreated control. Consequently, parasite-induced fish mortality was reduced significantly. A complete interruption of trophont recruitment was achieved by immersion in the *M. pruriens* extract. In vitro tests led to a 100 % mortality of *I. multifiliis* in 150 mg l<sup>-1</sup> *M. pruriens* extract, and in 200 mg l<sup>-1</sup> of *C. papaya* extract after 6 h. Although the active constituents of the medicinal plant extracts are still unknown, we have demonstrated that they have potential for effective control of *I. multifiliis*.

**Keywords:** *Ichthyophthirius multifiliis*, methanolic extract, *Mucuna pruriens*

## Screening of Environmental Effects on the Spawning Activity of Nile Tilapia

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For a profitable Nile Tilapia aquaculture the management of broodstocks by synchronising their spawning activity can be beneficial, especially among intensified conditions, where large amounts of eggs and larvae can be necessary at a given time. Due to the short spawning intervals in Nile Tilapia females (*Oreochromis niloticus*) the introduction of ovulation by hormonal treatments appears to be difficult and expensive. The aim of the present study was to test the potential of different environmental factors in synchronising the spawning activity of *O. niloticus* females. Mature females (Lake Manzala population, Egypt) were transferred into 350 l-aquaria in groups of ten to twelve individuals where they were initially kept among optimum water parameters for spawning (temperature: 28°C; acidity: pH6.6; hardness: 9.4°GH; salinity: 0.2ppm). After acclimatisation, treatment groups were adapted to high hardness (30–40°GH) or high salinity (15–22ppm), respectively and kept among these suboptimum conditions. By daily observations for readiness to spawn in treatment groups the potential of the tested environmental influences to suppress spawning activity was determined in relation to adequate untreated control groups. After 21 to 28 days among suboptimum conditions the treatment groups were adapted back to the optimum water parameters and the spawning activity was monitored for another week, to check for initiated synchronous spawns. Furthermore, 18°C-temperature treatments and pH5.0-treatments for 60 hours were similarly tested as short term environmental effects on spawning activity. Treatments and the corresponding controls were carried out in replicates. To determine the influence of the tested environmental conditions on fecundity and egg quality, eggs from spawning females were artificially stripped, inseminated and their developmental rates were observed. The best synchronisation effects were obtained after treatments with 22ppm salinity. In six replicated groups no spawning activity was found during treatments whereas 47 % of the females spawned in the week after treatments. In the corresponding control groups 49 % of the females spawned but only 11 % were achieved during the last week. Although fecundity and hatching rates were negatively effected by high salinity, per group member the output of swimming larvae during the last observation week increased distinctly after treatments (n=285 versus n=101 in controls).

**Keywords:** Aquaculture, environment, *Oreochromis niloticus*, reproduction, salinity, spawning, synchronisation

## **Survival and Growth Comparisons of Rainbow Trout Populations (*Oncorhynchus mykiss*) under the Specific Environmental Conditions in Northern Thailand**

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A comprehensive performance comparison of different rainbow trout populations was conducted at Doi Inthanon Fisheries Research Unit over two experimental series in order to identify genetic differences between populations under the specific production conditions of Northern Thailand. Eyed eggs of seven populations were transferred from the Experimental Trout Station Relliehausen, University of Göttingen, to Doi Inthanon Fisheries Research Unit. Here a special system for population testing in trout was developed. This consisted of separate hatching and rearing of populations till the end of the first feeding stage under two water temperature regimes (11°C, 14°C), further separate rearing of each population up to markable size under ambient water temperatures and common fattening up to pan-size weight. This weight was achieved 8 months after hatching. Whereas no significant differences between populations were found with regard to hatching rates under a temperature regime of 11°C, significant differences between populations were observed for hatching rates under the higher water temperature regime. Here hatching rates ranged from 67 % to 95 % between populations. Survival rates till the end of first feeding (range from 88 % to 97 %) were similar under both temperature regimes and showed significant differences between populations. Survival rates from the first feeding stage to rearing weights of markable size were high and between 96 % to 99 % with no significant differences between populations. Thereafter till pan size weight, survival rates of populations differed between 88 % and 98 % . Significant differences of up to 22 % for rearing and fattening weight were observed between populations. The observed differences in survival and growth performance between populations were quite distinct. It is therefore apparent that careful selection of stock to be used for both production and breeding is of significant importance.

**Keywords:** Aquaculture, Thailand, performance comparison, rainbow trout populations

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## Cryopreservation of Nile Tilapia (*Oreochromis niloticus*) Sperm

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Cryopreservation of sperm can be a vital tool in gamete and broodstock management of cultured fish species. A stable supply of sperm for optimal utilisation in hatchery production and laboratory experiments can be ensured. Rare genetic material can be conserved and transported in an economical way and experimental materials for advanced studies can be made more accessible. Cryopreservation of sperm is used increasingly in the production of fish with wide variability of fertility rates obtained with frozen-thawed sperm depending on the species and procedures employed. Cryo-straws were most frequently used to package sperm samples, however many researchers pelleted sperm samples on dry ice. In this study different procedures were optimised for Nile Tilapia (*Oreochromis niloticus*) sperm cryopreservation with focus on the comparison of the two packaging methods, pellets and 0.25ml-cryo-straws. Before each optimisation experiment fresh sperm was collected by artificial stripping of a random sample of five males (Lake Manzala strain, Egypt). Different diluents, cryoprotectants, freezing and thawing procedures were tested. Successful cryopreservation and thawing was verified by microscopic examination of sperm motility and by comparison of fertilisation- and hatching rates of artificially stripped and inseminated tilapia eggs. Promising results were obtained with the following procedures: sperm was diluted 1:5 with the extender containing 15 % milk (3.5 % fat, homogenised) and 5 % methanol in 0.6 M sucrose solution. Freezing in straws was realised by floating them 5 cm above of the surface of liquid nitrogen before submerging them into the liquid nitrogen. Packaging with pellets was practised on dry ice before depositing the pellets in liquid nitrogen. Pellets and straws were thawed in 0.1 M NaHCO<sub>3</sub> before microscopic inspection and fertilisation experiments were conducted in comparison to fresh sperm. In replicated trials, the mean hatching rates after fertilisation with straw-frozen sperm corresponded to 85 % and with pellet-frozen sperm to 59 %, if compared with the fresh sperm fertilisations (100 %). Packaging by pellets represented the more time efficient method, whereas packaging by straws eased the handling of small amounts of sperm and allowed tagging and recognition of individual samples.

**Keywords:** Aquaculture, cryo-straw, cryopreservation, *Oreochromis niloticus*, pellet, sperm

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## Development of a YY-male Tilapia (*Oreochromis niloticus*) Strain and Growth Performance Testing of the Genetically All Male Progenies

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Males represent the preferred sex as seed material in Nile Tilapia (*Oreochromis niloticus*) aquaculture as they show better growth if compared with females. Furthermore, as monosex populations do not tend to show stunting effects the use of all male production populations has since many years been recognised as an effective tool to increase production. The main objective of the present study was the development of so called YY-males in *O. niloticus* which produce all male offspring in normal matings. In a first step diethylstilbesterol (500 mg/kg of feed) was orally administered for 40 days to first feeding progenies from an exceptional mitotic gynogenetic male (YY), known to produce only all male offspring, and normal females (xx) (Lake Manzala population, Egypt). The resulting individuals were functional females but possessed a genetically male (XY) status. Progenies of these functional females (XY) with normal males (xy) resulted in approx. 25 % yy-males, which were verified by progeny sexing. Only males, which produced 100 % male progenies (n>50) with a random sample of at least three normal females were designated to be YY-males. For the easy continuation of the YY-male status in a breeding strain, YY-females are needed. To obtain YY-females YY-males were mated with functional females (XY), their progenies (approx. 50 % of them were genetically YY-males) were changed to functional females by diethylstilbesterol enriched feed and the needed YY-females were verified by progeny sexing. By mating YY-males with YY-females YY-male offspring was produced in large quantities. To get first information about the growth potential of the newly developed YY-male strain, performance comparisons between all male groups (progenies of YY-ales mated with normal females (xx)) and traditional mixed sex groups were conducted in 80 l-units. The all male groups were 14.1 % larger if compared with the whole mixed sex groups and from comparable size if compared with the males within the mixed sex groups.

**Keywords:** All male, aquaculture, growth performance, gynogenesis, *Oreochromis niloticus*, YY

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## Induced Spawning and Early Development of Stonelapping Minnow, *Garra cambodgiensis* TIRANT

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The stonelapping minnow belongs to the family “Cyprinidae” and is native to the Mekong and Chao Phraya basins. The species inhabits rocky bottoms of swiftly moving water of small and medium-sized streams and feeds on periphyton, phytoplankton and insects. In Thailand, this species has importance as ornamental fish and is used as protein source by hill tribe people. In the past the fish was found abundantly in the streams, but nowadays the numbers are decreasing substantially. A restocking programme is planned, however, till now no information is available about artificial reproduction of this species. To fill this gap of knowledge the following experiments have been carried out. Adult fish (n=406) were collected from the Maejam and Chiang Dow district in ChiangMai province in April, May and October 2001 and brought to the ChiangMai Inland Fisheries Research and Development Center, where the fish were kept in aquaria and fed with tadpole feed (41 % crude protein). In September 2001 and in July 2002, eight and 24 mature females, respectively, were observed. All these females were injected with LHRHa (10 microgram/kg body weight) and domperidone (5 milligram/kg body weight). After injections, groups of 8 fish per sex were kept together in separate units (water temperature 25–29°C). The brood fish started spawning around 12 hours after injections. The spawning success and the fertilisation rates of the September experiments were 71 % and 44 % and 79 % and 56 % in July. Eggs were grey, of round shape, semi-buoyant and 2.2mm in diameter after water absorption. The incubation period was 15–16 hours at 25–29°C water temperature with hatching rates of 74 % in September and 85 % in July experiments. Newly hatched fry had an average length of 3.3mm. After hatching, fry were kept in stocking densities of 500, 1000, and 2000 fry in 12-l-water volume for first feeding. The feeding regime consisted of ad libitum feeding of rotifers and moina for two weeks, followed by ad libitum feeding of a paste of tadpole feed (41 % crude protein). At the end of the 27 days first feeding period, survival rates were 92, 94 and 98 %.

**Keywords:** Aquaculture, early development, *Garra cambodgiensis*, induced spawning

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## **Effects of Feeding Regimes on Carcass Traits in Triploid and All-male Nile Tilapia Populations (*Oreochromis niloticus*)**

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To avoid the problem of stunting, production of all-male and triploid stocks are methods in Nile Tilapia (*Oreochromis niloticus*) aquaculture to increase the overall productivity. All-male populations are known to facilitate culture in a broad range of systems as they show better growth performance and homogeneity if compared to mixed sex populations. Due to their functional sterility the use of triploid seed represents an effective approach to eliminate negative effects of uncontrolled reproduction. Although triploid fish show various advantages, especially females tend to produce large amounts of intestinal fat if subjected to ad libitum feeding regimes. Fodder could be saved if the energy, deposited in intestinal fat stores, would be utilised for somatic growth. Therefore an eight week feeding trial during the early growth period was conducted to investigate the effects of different feeding regimes on the body composition of three different genetic groups of tilapia (Lake Manzala strain, Egypt: mixed sex, triploid, all-male) with emphasis on intestinal fat deposition. Three month old tilapia of the different genetic groups, stocked in replicates of 26 fish in 80 l-aquaria in a recirculating system, were either fed ad libitum three times a day or subjected to food deprivation every second day. At five month of age all fish were slaughtered and carcass traits were measured. Males fed ad libitum had a 60 % better growth compared to the restricted groups. The all-male groups showed the best overall growth capacity. The growth of females in the restricted regime was 92 % inferior to the growth of their daily fed counterparts. Food deprivation did not result in decreased amounts of intestinal fat in the triploids, neither in males nor in females, during the early fattening phase under the given feeding regimes. Only in the all-male groups intestinal fat was significantly affected by food restriction.

**Keywords:** All-male, aquaculture, carcass composition, feeding regimes, *Oreochromis niloticus*, triploid

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## Sustaining Tropical Marine Diversity of Coral Reefs in Costa Rica and Panama

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Research has been done at patch reefs in Bocas del Toro in Northwest Panama and at the barrier reefs at marine protected areas along the coast of Costa Rica. The variations between healthy and dying reefs spots are immense, the difference lies in the location either open to the incoming sea or places protected from the wind and waves behind small islands. The richness of species, the grade of destruction and the reasons why they corals show signs of severe degradation were observed.

Human activities are the main reason for a process of destruction. Extensive banana plantations are wide-spread in the region and one factor for endangering the coral reefs. They are 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 bananas, the local industry is conserving the fruits with chemicals before they are being shipping overseas for export. The sea water is being contaminated 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. A further factor is the development of tourism and uncontrolled infrastructure developments. Construction activities and deforestation lead to additional sedimentation resulting in deteriorated light conditions. Poison from inadequately detoxified waste and nutrient entries with the waste water disturb the ecological balance of the sea. A heavy earthquake in 1991 accelerated the already worsening situation of the reefs due to geomorphological changes on the mainland with the consequence of further sediment loads. Warming sea temperatures 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. Only by conserving the marine resources the local population has a long-term economic and social basis to live on. A sustainable management strategy has to comprise physical measurements against soil erosion, e.g. agroforestry as an alternative land-use form, and socio-economic solutions like the development of ecological tourism in combination with a consequent environment policy.

**Keywords:** Caribbean coast, coral reefs, degradation, Latin America, marine protected areas, protection measurements, tropical ecology

## Investigations on Reproduction Biology of Bronze Featherback, *Notopterus notopterus* PALLAS

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At present world aquaculture production is characterised by using only very few fish species. This led to an intercontinental drift and introduction of non-native fish species into aquatic habitats with no foreseeable ecological consequences. The low diversity of fish species used for aquacultural purposes is particularly caused in our restricted knowledge on reproduction biology of most fish species. The Bronze Featherback (*Notopterus notopterus*) is an important commercial fish for human consumption in Southeast Asia captured in natural habitats. In order to satisfy market requirements reproduction cycle should be investigated to ensure an aquacultural use.

Due to the fact that Bronze Featherback spawn in natural habitats during the rainy season, it can be suggested that environmental conditions seem to induce maturation and reproduction. Therefore the study is focused on the influence at varying conductivities (as we can find in the natural habitats during the rainy season) on gonad maturation.

The experiment comprises three groups with an average size of 20 cm (n=30). In the first four weeks all fish are reared in a recirculation-system to ensure comparable environmental conditions. Afterwards, two groups of *Notopterus notopterus* will be kept under varying conductivities over a period of 8 weeks, while environmental conditions in group 3 are unchanged acting as control. Water conductivity in tank of group one decreases from 800 to 100  $\mu\text{s/cm}$  and simulating rainy season. Dry season is imitated in group two by a increasing water conductivity of from 800 to 1200  $\mu\text{s/cm}$ . Gonad maturation is determined by Gonado-Somatic-Index (GSI) and plasma steroid level (males: 11-keto-testosterone, females: estradiol) every 14 days.

It can be assumed, that simulation of rainy season conditions in terms of water conductivity will induce maturation of gonads, which control will be helpful for introduction *Notopterus notopterus* in aquaculture.

**Keywords:** Aquaculture, *Notopterus notopterus*, reproduction biology, gonad maturation

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