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Resource Management and Rural Development

Utilisation of diversity in land use systems: Sustainable and organic approaches to meet human needs

Book of Abstracts

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Preface

The TROPENTAG is an International Conference for Research on Food Security, Natural Resource Management and Rural Development. Since 1999 it is convened alternately by a number of German Universities in co-operation with ATSAF and GTZ/BEAF, all of which are engaged in agriculture and forestry in tropical countries. The TROPENTAG provides an international platform for scientific and personal exchange for students, junior and senior scientists, and development practitioners alike. The increasing international interest in the TROPENTAG from a large and still growing audience - over 650 participants from 68 countries have registered so far - demonstrates its importance on the agenda of both, the development oriented scientific community and the implementing development organizations.

This year's TROPENTAG is organised jointly by the University of Kassel-Witzenhausen and the University of Göttingen under the conference theme "Utilisation of diversity in land use systems: Sustainable and organic approaches to meet human needs". This theme covers many challenging aspects: diversity may refer to the (genetic) diversity of the natural resource base on which anthropogenic land use relies, and to the entire ecosystem with which this land use is interacting. Here, we understand diversity in a broad sense: it encompasses the diversity of the natural flora and fauna at the micro to the macro scale, and also, for example, variation of soils or site conditions. Diversity may also refer to the genetic diversity of domesticated plant and animal species, which over millennia supports livelihoods in almost all climates and regions worldwide. Utilizing diversity may mean harvesting non-timber forest products such as mushrooms, medicinal plants or wildlife, or to combine different crops in intercropping systems to better exploit compatibilities in time or space securing multiple household needs. Diversity may also refer to the large cultural diversity of human societies in different regions of the world, who have developed their individual knowledge and technologies to derive their livelihoods from the resource base at hand.

Rapid population growth causes an increasing strain on the resource base, and urbanisation and the emergence of a new middle class in many upcoming economies leads to a dramatically growing demand livestock products on one hand and energy on the other. The recent past has shown that this may massively influence agricultural markets and practices across the world. Depending on biophysical and socio-economic conditions, export-oriented land use systems may or may not be less diverse than

systems producing for more localized markets. Whether or not smallholders do economically benefit from such developments can only be answered at the individual (regional) level.

The TROPENTAG 2007 seeks to bring scientists and development practitioners together to stimulate and advance the scientific debate on the above issues. New methods and research results are presented addressing the eternal question of how we may reconcile increasing demands for food and energy by a growing world population and peoples' search for improved livelihoods with our vision of sustainability and conservation of biodiversity in agro-ecosystems. In this context emphasis will also be placed on searching for discipline-specific indicators of sustainability and trying to combine these in a way that allows their useful application in assessing land use systems. To broaden the accessibility of the results of this venue the abstracts of all contributions are published both as hardcopies and on the Internet under www.tropentag.de.

Witzenhausen and Göttingen, October 2007

for the Organising and Scientific Committee

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Contents

Plenary Session	7
I Resource use efficiency and diversity in agroecosystems	11
a) Livestock nutrition and feed quality	13
b) Livestock and fodder production systems	47
c) Livestock genetic resources and production systems	65
d) Technological innovations in agriculture	79
e) Land use and livelihood strategies	101
II Towards the millennium development goals: Innovation and adoption in agriculture and forestry	123
a) Agricultural marketing and rural institutions	125
b) Food security and food safety	145
c) Determinants of technology adoption and implications for policy and program design	177
d) Sustainable development in practice - examples from GTZ's projects	191
e) Research for development practitioners	197
III Diversity of land use and livelihood systems in the face of global change	211
a) Biodiversity and crop production	213
b) Biodiversity	229
c) Agroforestry and non-tree forest products	247
d) Forestry	267
e) Conservation, environmental services and value chains in the Amazon region (GTZ, ACTO, AI, UNAMAZ)	287
IV Ecosystem services in forest and agrarian landscapes	297
a) Biofuels	299
b) Scientific basis of ecosystem services	313
c) Assessment and valuation of ecosystem services	319
d) Institutions and management of ecosystem services	331
e) Trade-off between conservation and development goals	345
V Current advances in analysis and modelling techniques	349
a) Current advances in analysis techniques	351
b) New applications of modelling	369

c)	Spatial explicit modelling of land use change	383
d)	Soil fertility and management of organic matter	397
e)	Organic agriculture	415
VI	Food production, food quality and food safety	427
a)	Resource use and fertility management	429
b)	Water use: current situation and perspectives	459
c)	Cropping techniques in dry and humid areas	479
d)	Plant protection	493
	Index of Authors	527
	Index of Keywords	539

Plenary Session

MIGUEL ALTIERI:

Agroecology: The Science of a Sustainable and Resilient Agriculture for the XXI Century

8

Agroecology: The Science of a Sustainable and Resilient Agriculture for the XXI Century

MIGUEL ALTIERI

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Today there is considerable consensus that modern agriculture confronts an environmental crisis. A growing number of people have become concerned about the long-term sustainability of existing food production systems. Evidence has accumulated showing that whereas the present capital- and technology-intensive farming systems have been extremely productive and competitive, they also bring a variety of economic, environmental and social problems. An alternative food system is urgently needed.

From an ecological perspective, the regional consequences of monoculture specialisation are many-fold including the high use of agrochemicals (pesticides and fertilisers), and lately the use of transgenic crops, which are increasingly been linked to a an array of environmental problems, the worsening of insect pest and disease infestations and higher vulnerability to climate change. Moreover the efficiency of use of applied inputs is decreasing and crop yields in most key crops are leveling off. In some places, yields are actually in decline. There is no question that high-input conventional agricultural systems need to be converted to systems that require less use of external inputs and that are able to produce high quality food without degrading the environment

On the other hand it is now well accepted that vast areas in the developing world, characterised by traditional/subsistence agriculture, remain poorly served by the top-down transfer-of-technology approach, due to its bias in favour of modern scientific knowledge and its neglect of local participation and traditional knowledge. For the most part, resource-poor farmers gained very little from the Green Revolution. Not only were technologies inappropriate for poor farmers, but peasants were excluded from access to credit, information, technical support and other services that would have helped them use and adapt these new inputs if they so desired. The urgent need to combat rural poverty and to conserve and regenerate the deteriorated resource base of small farms requires an active search for new kinds of agricultural research and resource management strategies. Many people have long argued that a sustainable agricultural development strategy that is environmentally enhancing must be based on agroecological principles and on a more participatory approach for technology development and dissemination.

Agroecology has emerged as the discipline that provides the basic ecological principles for how to study, design and manage agroecosystems that are both productive and natural resource conserving, and that are also culturally sensitive, socially just

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and economically viable. Agroecology goes beyond a one-dimensional view of agroecosystems - their genetics, agronomy, edaphology, etc., - to embrace an understanding of ecological and social levels of co-evolution, structure and function. Instead of focusing on one particular component of the agroecosystem, agroecology emphasises the interrelatedness of all agroecosystem components and the complex dynamics of ecological processes. Implicit in agroecological research is the idea that, by understanding these ecological relationships and processes, agroecosystems can be manipulated to improve production and to produce more sustainably, with fewer negative environmental or social impacts and fewer external inputs. Ecological concepts are utilised to favour natural processes and biological interactions that optimise synergies so that diversified farms are able to sponsor their own soil fertility, crop protection and productivity.

This paper argues that agroecology can provide the scientific and methodological basis for converting large scale industrial systems monoculture systems to a more sustainable path of production. Agroecology is also providing a new technological paradigm for resource-poor farmers to achieve productive, energy and food sovereignty. Of course conducive policies, alternative markets and organised social movements are required for agroecology to fulfil its development potential.

Keywords: Agroecology, ecological concepts

Resource use efficiency and diversity in agroecosystems

a)	Livestock nutrition and feed quality	13
b)	Livestock and fodder production systems	47
c)	Livestock genetic resources and production systems	65
d)	Technological innovations in agriculture	79
e)	Land use and livelihood strategies	101

Livestock nutrition and feed quality

Oral Presentations	17
LAILA C. BERNAL, TASSILO TIEMANN, CARLOS LASCANO, MICHAEL KREUZER, HANS-DIETER HESS: Effect of Supplementing a Tanniniferous Shrub Legume on Milk Yield and Composition of Dual Purpose Cattle Grazing <i>Paspalum notatum</i>	17
MARTHEN LUTHER MULLIK: Efficiency of Microbial Protein Synthesis in Steers Fed Freshly Harvested Tropical Grass	18
JOHNNY ONYEMA OGUNJI, THILO PAGEL, CARSTEN SCHULZ, WERNER KLOAS: Apparent Digestibility Coefficient of Housefly Maggot Meal (magma) for Nile Tilapia (<i>Oreochromis niloticus</i> L.) and Carp (<i>Cyprinus carpio</i>)	19
DAI NGUYEN VAN, WERNER BESSEL: Potassium Chloride Supplementation in Drinking Water of Laying Hens as a Means to Maintain High Productivity under High Ambient Temperature	20
Posters	21
CHOKO MIKLED, THERDCHAI VEARASILP, UDO TER MEU- LEN, SONTAYA MOONSIKEAW: Nutritive Value and Utilisation of Ruzi (<i>Brachiaria ruzizien- sis</i>) and Napier (<i>Pennisetum purpureum</i>) Grass Silages by Cattle	21
HENDERIANA BELLI, I. GUSTI NGURAH JELANTIK, WOLF- GANG HOLTZ: Effect of Supplementation of Grazing Bali Cows During Pre and Postcalving Period on Intake, Digestibility, and Rumen Environment	22
SVENJA MARQUARDT, FELIX ENCINAS, STEPHAN BECK, HUM- BERTO ALZÉRRECA, MICHAEL KREUZER, ANDREA CORINNA MAYER: Plant Species Selection by Free-Ranging Cattle in Subandean Mountain Forests of Southern Bolivia	23

- KAMAL EL DIN HASSAN ALI ELTOM, HELGE BÖHNEL, FRANK GESSLER, ABDULKHALIG BABIKER, NASREEN OMER MUSA:
***Haemophilus somnus*: A Cause of Chronic Encephalopathy of Cattle in the Sudan?** 24
- ROQUE G. RAMÍREZ LOZANO, HUMBERTO GONZÁLEZ RODRÍGUEZ:
Seasonal Trends of Mineral Content in Forage of Range Grasses from Northeastern Mexico 25
- EUSTACE AYEMERE IYAYI, HOLGER KLUTH, MARKUS RODEHUTSCORD:
Diversification in the Use of the Seeds of Five Soil Nitrogen Enriching Tropical Plants Used on Marginal Lands for Livestock Production 26
- SEIMIYENKUMO TARIA OFONGO, ANTHONY D. OLOGHOB:O:
Processed Kidney Bean (*Phaseolus vulgaris*) in Broiler Feeding — Performance Characteristics 27
- OYEBIODUN LONGE, GBEMIGA ADEYEMO, LAWAL AKINTAYO:
Effects of Feeding Desert Locust Meal (*Schistocerca gregaria*) on Performance and Haematology of Broilers 28
- OLUFEMI P.A. OLOWU, J. OLUWASOLA AGBEDE, V. AYOBORE ALETOR:
Effects of Roxazyme -G on Growth Indices and Haematological Variables of Broilers Fed Maize Offal-Based Diets 29
- MOHAMMAD JAFARI, OPES MATANMI:
Sustainable Utilisation of Cassava Plant for Feeding Monogastric Animals 30
- AKINYELE OLUWATOMISIN KINGSLEY ADESEHINWA, OLUMIDE OLUTAYO OBI, AYODEJI ADEBAYO:
Utilisation of Cassava Peel Based Diet Supplemented with or without Farmazyme® 3000 Proenx by Growing Pigs 31
- THERDCHAI VEARASILP, RUJIRAK TURAGIJ, SANCHAI JATURASITHA, T. APICHARTSRUNGKON, NATTAPHON CHONGKASIKIT, NUCHA SIMASATIKUL, KESINEE GATPHAYAK, UDO TER MEULEN:
Dried Betel Vine (*Piper betel* Linn) Leaves as Feed Additive in Weaning Pig Diets 32
- NUCHA SIMASATIKUL, DUANGPORN PICHPOL, PHAKTEMA BOONRUANG, PAWIN PADUNGTOD, KESINEE GATPHAYAK, PRAPAWADEE PIRINTRA, PANUWAT YAMSAKUL, UDO TER MEULEN:
Antibacterial Activity of Crude Extracted Betel Vine Leaf Against *Salmonella* spp. 33

DONALD I OSUIGWE, C. NWOSU, JOHNNY ONYEMA OGUNJI: Preliminary Observations on some Haematological Parameters of Juvenile <i>Heterobranchus longifilis</i> Fed Different Dietary Levels of Raw and Boiled Jackbean (<i>Canavalia ensiformis</i>) Seed Meal	34
MOSUN OLUFAYO: Proximate and Mineral Composition of <i>Parachanna obscura</i> Juveniles Exposed to <i>Derris elliptica</i> Root Powder	35
NGUYEN NGOC TUAN, SILKE STEINBRONN, DONGMEZA EULOGE BRICE, BUI DUNG, ULFERT FOCKEN, KLAUS BECKER: Growth and Feed Conversion of the Grass Carp (<i>Ctenopharyngodon idella</i>) Fed on Fresh Plant Material under Laboratory Conditions in Viet Nam	36
KHALED MOHAMED: Validation of Essential Amino Acids Requirements of Red Tilapia (<i>O. mossambicus</i> × <i>O. hornorum</i>) Assessed by the Ideal Protein Concept	37
HANNO SLAWSKI, KLAUS-PETER GÖTZ, CARSTEN SCHULZ: The Use of Enriched 15N as an Indicator of the Assimilation of Fish Meal, Pea Seed Meal and Housefly Maggot Meal Protein in the Diet of <i>Oreochromis niloticus</i>	38
ANDREAS STAMER, RALPH NEIDIG, STEPHAN WESSELS, GABRIELE HÖRSTGEN-SCHWARK: Protein Concentrates for Animal Feedstuff Derived from Fly-Massproduction: <i>Hermetia</i>-Meal as an Alternative to Fishmeal	39
ANDREA CORINNA MAYER, IMKE JOHANNA DE BOER: Towards Ecological Sustainability in (sub)tropical Animal Nutrition - Life Cycle Assessment as a Tool to Identify Environmentally Sound Feeding Options	40
CÉLINE CLÉMENT, NICOLE MILENA LOCHER, DANTE PONCE AGUIRRE, IKHLAS AHMAD KHAN, IVAN MANRIQUE, MICHAEL KREUZER, ANDREA CORINNA MAYER: Influence of Colour Type on the Concentration of Potential Fertility Enhancing Secondary Metabolites of the Andean Plant Maca (<i>Lepidium meyenii</i> Walp)	41
UTA DICKHOEFER, ANDREAS BUERKERT, EVA SCHLECHT: Feed Intake of Supplemented Goats on Communal Pastures in the Al Jabal al Akhdar Mountains, Northern Oman	42
NASREEN OMER MUSA, SULIEMAN EL SANOUSI, ABDULKHALIG BABIKER, KAMAL EL DIN HASSAN ALI ELTOM: Outbreak of Morels Disease (Sheep Abscess disease) in the Sudan	43

JOERG JORES:
Collaborative German-ILRI Research to Discover New Diagnostic Tools for Contagious Bovine Pleuropneumonia, the Most Devastating Cattle Disease in Africa 44

TEKA OSCAR, VOGT JOACHIM, KINDOMIHOU VALENTIN, HOUES-SOU LAURENT, SINSIN BRICE:
Socio-Economic and Ecological Analysis of the Use of Controlled Fires in Pastoralism: Cases of two Agroecological Zones of Benin 45

Effect of Supplementing a Tanniniferous Shrub Legume on Milk Yield and Composition of Dual Purpose Cattle Grazing *Paspalum notatum*

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Low availability and poor quality of forages for livestock are major constraints faced by tropical smallholders. This is particularly relevant in regions with low-fertility soils and extended dry seasons. Shrub legumes have been suggested as promising feeds in the dry season, and CIAT has selected some accessions of species with good agronomic performance on low-fertility soils and under drought. Many of these species are characterised by high contents of condensed tannins (CT). Particularly one accession of *Calliandra calothyrsus* showed auspicious potential regarding ruminal fermentation dynamics in vitro and was therefore tested for its suitability as supplement to grazing cattle. In a duplicated 4 × 4 Latin Square design, 8 dual purpose cows (Holstein × Zebu) kept on a *Paspalum notatum* pasture, were supplemented with *Vigna unguiculata*, a more difficult to grow high quality herbaceous legume, and *C. calothyrsus* (CIAT 22310) alone or in mixtures at proportions 1:2 and 2:1. Allowance for supplementation was set to 1 kg of dry matter per 100 kg of body weight. Cows were allowed to adapt for 7 days, followed by 7 days of measurement. Milk yield and composition were measured daily. Consumption of the legumes was 87 % of the amount offered with *Vigna* and only 29 % with *Calliandra*. The mixture with low *Calliandra* proportion did not differ in consumption from the *Vigna*-only supplement, while that with the high *Calliandra* proportion was intermediate with 59 % of the amount offered ($P < 0.05$). Milk yield linearly decreased with increasing proportion of *Calliandra* in the supplement. Accordingly, milk yield was highest ($P < 0.001$) with *Vigna*-only (5.3 kg d⁻¹), and declined to 4.7, 4.4 and 3.6 kg d⁻¹ with increasing *Calliandra* level. There were no treatment effects on contents of fat, solids-non-fat and total solids. Milk urea N declined ($P < 0.05$) with increasing *Calliandra* proportion from 6.3 to 3.7 mg dl⁻¹ as expected from the protein-binding properties of the *Calliandra* CT. In conclusion, *C. calothyrsus* had a low suitability as sole protein supplement, but it may be added at low proportions if availability of *Vigna* is limited. When supplemented, a major limitation seems to be the low palatability apart from the high CT content.

Keywords: Calliandra, legumes, milk production, supplementation, tannins

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Efficiency of Microbial Protein Synthesis in Steers Fed Freshly Harvested Tropical Grass

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Rumen microbial crude protein (MCP) supply is a vital element in the rumen models to predict respond of ruminants to a certain feeding regime. Data from tropical pastures always below predicted results from the existing rumen models due to the fact that database used in the models are derived mainly from temperate pastures. Thus, quantification of the rumen MCP supply from tropical pastures is expected to improve predictive rate of the models under tropical feeding condition. Four Brahman cross-bred steers (457 ± 20.1 kg) were used in a metabolism study to quantify efficiency of microbial protein synthesis (EMPS) in cattle consuming a freshly harvested tropical grass. Pangola grass (*Digitaria erianthe* cv. Steudal) was harvested every morning and fed to the animals soon after. Data were collected over 1 week after the steers were previously adapted to this diet for 2 weeks. Parameters regarded were EMPS, intake, fractional passage rates, and rumen ammonia concentration. Passage rates were estimated using dual marker (chromium-EDTA and ytterbium) technique. The EMPS was estimated using purine derivative excretion in urine (total urine collection method). The EMPS value obtained was compared to the values in the feeding standards. Mean crude protein (CP) and water soluble carbohydrates (WSC) were 6.3 and 7.4 of dry matter (DM) respectively. Mean DM intake was 1.6 % W. Average rumen ammonia ($\text{NH}_3\text{-N}$) concentration was 69 mg $\text{NH}_3\text{-N l}^{-1}$ whilst rumen passage rates were 7.48 and 6.92% h^{-1} for fluid and solids respectively. Mean EMPS in the steers was only 72 g microbial crude protein (mcp) kg^{-1} digestible organic matter (DOM). It might be concluded that EMPS in steers consuming freshly harvested pangola grass, with the above nutritional characteristics, was below the minimum level for forage diets adopted in the current feeding standards.

Keywords: Efficiency, rumen microbial proteins, steers, tropical grass

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Apparent Digestibility Coefficient of Housefly Maggot Meal (magmaeal) for Nile Tilapia (*Oreochromis niloticus* L.) and Carp (*Cyprinus carpio*)

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Several feed ingredients including animal and plant protein sources, have been investigated in order to find substitutes for fish meal in fish diets. Though these feed ingredients may be cheaper than fishmeal, diverse responses on growth parameters have been reported. The reasons for the variations are summarised to include the protein composition and amino acid profile, palatability/acceptability, phosphorus content and availability, anti-nutritional factors (especially in plant protein sources) and apparent digestibility of alternative feeds. Digestibility gives the relative measure of the extent to which ingested food and its nutrient components have been digested and absorbed by animal. From its chemical composition a feed ingredient may appear to be an excellent source of nutrients but unless it can be digested and absorbed in the target species the actual value can be limited. Interests to study the use of housefly maggot meal (magmaeal) as substitute for fishmeal in fish diets have increased in recent. However, no report has been published so far on the digestibility of this alternative protein source. This study was therefore designed to determine the apparent digestibility coefficient of magmaeal for Nile tilapia (*Oreochromis niloticus*) and carp (*Cyprinus carpio*). In order to evaluate the digestibility of magmaeal formulated reference diet (containing fishmeal as primary protein source) and a test diet (containing 70% reference diet + 30% maggot meal) were fed triplicate groups of tilapia and carp with initial average body weights of 108.3±32g and 110.3±23g respectively. Faeces were collected over a period of 15 days by siphoning. The apparent digestibility coefficients (ADCs) of tilapia fed with test diet was lowest (80.11%) and significantly different from carp (87.08±0.8), however no difference was observed with ADC of crude fat. Magmaeal digestibility of dry matter (47.65%), crude protein (57.7%), crude fat (86.1%) and energy (58.1%) for tilapia are significantly lower than for carp (dry matter: 63.84%, crude protein: 84.9%, crude fat: 96.8%, energy: 74.9%). Spawning activities of experimental tilapia and soft faeces consistency of carp may have affected the results.

Keywords: Carp, fibre, housefly maggot meal, nutrition, Tilapia

Potassium Chloride Supplementation in Drinking Water of Laying Hens as a Means to Maintain High Productivity under High Ambient Temperature

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Voluntary water intake in laying hens is considered an important factor of adaptation to hot temperatures. This experiment was carried out to study the response of potassium chloride (KCL) in the drinking water on water intake, feed intake and productivity traits under heat challenge. A total of 48 hens (Hisex breed) were kept in climatic chambers and randomly allocated to three experimental groups of 16 hens each. These groups were given 0; .2 and .4 % KCL in the drinking water for seven consecutive days. The room temperature was cycled from $21\pm 1^{\circ}\text{C}$ (from 23 to 8 hrs) to $34\pm 1^{\circ}\text{C}$ (from 9 to 22 hrs) for seven days. Water and feed intake, egg production and quality traits of the individual hens were recorded throughout the experimental period. Body temperature was recorded at days 1, 3, 5 and 7. Water intake was significantly higher in the hens receiving .2, .4 % vs. 0 % KCL supplementation. There was no significant difference between .2 and .4 % KCL. Feed intake in the control group was significantly higher in the KCL-supplemented groups at day seven of experimental period. There was no effect of the treatments on egg shell strength, but shell thickness was significantly higher and the number of egg shell defects was lower in the KCL-treated hens. Body temperature was not affected by the treatments. The results show that KCL supplementation through drinking water may be a means to avoid a reduction of egg production which usually occurs when the temperature in the layer house increases.

Keywords: Egg production, feed intake, heat stress, potassium chloride, water intake

Nutritive Value and Utilisation of Ruzi (*Brachiaria ruziziensis*) and Napier (*Pennisetum purpureum*) Grass Silages by Cattle

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Four experiments were carried out to evaluate the nutritive value and potential utilization of ruzi (*Brachiaria ruziziensis*) and napier (*Pennisetum purpureum*) grass silages. The grasses were ensiled with different additives and assessments were carried out using conventional digestibility trials, indicator method and an in vitro gas production technique. In experiment I ruzi grass was ensiled with 5 % molasses (T1), 5 % molasses + 5 % coconut meal (T2), 5 % coconut meal (T3) and 3 % urea + 3 % rice bran (T4). In experiment II napier grass was ensiled with 5 % molasses (T1), 15 % cassava leaf (T2), 20 % soybean hulls (T3) and 20 % leucaena leaf (T4). In experiment III, four crossbred native × Holstein cannulated cows were used to assess in sequence the digestibility of the respective silages. In experiment IV, the Menke in vitro gas technique was used to derive the energy values of the silages. The quality of all silages was assessed to be good with a quality score ranging between 70.17 and 90.25. The pH was less than 4.1. The lactic acid content was significantly ($p < 0.05$) different with ruzi grass (T2) and with napier grass (T1) having the highest values. Metabolisable energy content was however highest in ruzi grass (T1) and for napier grass (T1). Efficiency of nitrogen uptake with ruzi grass was significantly ($p < 0.05$) highest with T1 while with napier grass this was significantly ($p < 0.05$) highest with T1 as well. Therefore Ruzi grass ensiled with 5 % molasses + 5 % coconut meal and napier grass ensiled with 5 % molasses were relatively better utilised than the other treatments. It is important to carry out further work assessing animal performance on the silages.

Keywords: *Brachiaria ruziziensis*, *Pennisetum purpureum*, silage, nutritive value, cattle

Effect of Supplementation of Grazing Bali Cows During Pre and Postcalving Period on Intake, Digestibility, and Rumen Environment

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Ten pregnant Bali cows were used to study effect of supplementation on intake, digestibility, and rumen environment. Approximately 90 d before the expected date of calving, cows were randomly allocated to one of two feeding groups. The 5 cows of Group A were grazed on native pasture, while the remaining cows of Group B grazed with the others but received 1.50 kg concentrate (coconut cake + fish meal + rice bran) with gross energy of native grass = 13.61 kg MJ⁻¹ and concentrate = 16.68 kg MJ⁻¹. Voluntary intake of basal diet and supplemented feeds by both groups was measured over successive 14-day periods including 7 days of preliminary treatment at 1 month after calving, while apparent digestibility was determined at 4–6 weeks after calving, and ruminal fluid was collected on the final day of the trial. Data was analysed using student-t test procedure. Forage intake particularly total dry matter (DM) intake was markedly increased ($p < 0.01$) when cows grazed on natural pasture were supplemented with concentrate (7.6 vs 6.0 kg). The estimated total energy intake also increased ($p < 0.01$) with supplementation. The intake of all the nutrients i.e. total organic matter (OM), crude protein (CP), ether extract (EE), crude fibre (CF) and nitrogen free extract (NFE) were significantly higher ($p < 0.01$) in the supplemented group than in the non-supplemented group. Digestibility data in the study showed that there were improvements after supplementation i.e. DM was significantly higher (66.7 vs 58.3 %); also digestibility of all nutrients except EE and NFE. Rumen pH, ammonia and VFA levels were affected by concentrate supplementation (pH: 6.4 vs. 6.7; NH₃-N: 137.4 vs. 11.0 mg l⁻¹; VFA: 115.2 vs. 86.2 nM l⁻¹). Molar proportion i.e. acetate, propionate and butyrate including acetate and propionate rati also influenced by supplementation (2.9 vs 3.9).

Keywords: Bali cows, digestibility, intake, native pasture, rumen environment, cattle

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Plant Species Selection by Free-Ranging Cattle in Subandean Mountain Forests of Southern Bolivia

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In southern Bolivia, Department of Tarija, the Subandean mountain forests are used as winter grazing areas for cattle. Practicing a transhumance system, the cattle is moved to the forests at the beginning of the dry season (April-May), when the forage in the grasslands of the valleys, used for summer grazing, becomes scarce. The cattle stays in the mountain areas during the complete dry season and returns to the grasslands around the villages when the rainy season starts (October-November). In the community of Salinas, inside the Reserva Nacional de Flora y Fauna Tariqufá, traditionally silvopastoral areas (Meringal (M) and Rio Tarija (T)) were chosen for evaluating the plant selection of cattle in free-ranging conditions, using direct observation. During 4 to 5-day periods per month from May to November, an adult cow was observed during daylight hours. The bites per plant species were counted every 5 minutes during a 1-minute period. From May to July, grasses and grass-like species made the highest contribution to the cattle's diet, contributing to more than 55 % of bites during May and June at both study sites. The main species consumed was the grass *Ichnanthus cf. pallens* (more than 50 % in both sites in May). In the following months, consumption of grasses and grass-like species decreased, and the contribution of herbs, shrubs and subshrubs, and trees increased in the diet. In area T, bites on shrubs and subshrubs were more frequent, especially in August (42.5 %), while in M more trees than shrubs and subshrubs were browsed, with highest values being found in September (45.2 %). Not only fresh plant parts served as food but also dry tree foliage was consumed, mainly during August to October, at both study sites, but with higher proportion of browsing at site M (September=35 %). The dry tree foliage was mainly derived from *Chrysophyllum gonocarpum* and *Celtis brasiliensis*. The results show a high diversity of plants consumed by cattle (approx. 376 species). In general, the ten most important plant species (including dry tree foliage of non-determined tree species) made up more than 50 % of bite counts.

Keywords: Biodiversity, forest grazing, Latin America, plant species selection, silvopastoral systems

***Haemophilus somnus*: A Cause of Chronic Encephalopathy of Cattle in the Sudan?**

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Haemophilus somnus (*Histophilus somni*) has been reported in many countries around the world as a cause of many disease manifestations in cattle and sheep including thrombotic meningoencephalitis, septicaemia, pneumonia, abortion, orchitis, arthritis and myocarditis, etc... which are collectively known as “*Haemophilus somnus* disease complex”. *Haemophilus somnus* disease has not been reported in the Sudan till 1998, when El Sanousi and co-workers diagnosed a chronic disease of cattle with nervous manifestations as “thromboembolic meningoencephalitis” caused by *Haemophilus somnus*. This disease was observed to affect cattle following stresses such as viral or parasitic diseases or exhaustion due to walking long distances. The disease is characterised by decreased heat tolerance and hair over growth in addition to other symptoms which include respiratory distress, hyper-salivation, plegia of one or both hind limbs, elevated temperature, decreased milk yield, reproductive failure and decreased appetite with consequent loss of body condition. In another separate study, the same investigators showed that most of these symptoms can be alleviated or abolished by treatment with antibiotics that can cross the blood brain barrier, confirming the their previous diagnosis of the disease and the bacterial nature of the causative agent. In the present investigation we revised the relation of *H. somnus* to this disease by re-identification of some of the early isolated bacteria by molecular methods. With PCR using primers specific to *H. somnus*, four of these isolates were either negative or yielded non-specific amplicons. Further identification by 16S rDNA sequencing confirmed the PCR results. Another part of the investigation was conducted using ELISA for the detection of anti-*H. somnus* antibodies in affected cattle. Although ELISA results showed varying degrees of antibody titre in sera from both affected and apparently healthy cattle, healthy cattle had relatively higher antibody titres against *H. somnus*. These results are consistent with results of other investigators, who reported that cattle with lower titre against *H. somnus* were more susceptible to *H. somnus* disease.

Keywords: Cattle thrombotic meningoencephalitis, *Haemophilus somnus*, *Histophilus somni*, Sudan

Seasonal Trends of Mineral Content in Forage of Range Grasses from Northeastern Mexico

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For grazing ruminants, native grasses are important sources of inorganic nutrients; however, in some circumstances, they are deficient in one or more essential minerals. The aim of this study was to determine and compare, seasonally, during one year (from autumn 2001 to summer 2002), the Ca, K, Mg, Na, P, Cu, Fe, Mn, and Zn content of native grasses such as *Bouteloua curtipendula*, *Bouteloua trifida*, *Brachiaria fasciculata*, *Digitaria insularis*, *Chloris ciliata*, *Leptochloa filiformis*, *Panicum halii*, *Panicum obtusum*, *Paspalum unispicatum*, *Setaria macrostachya*, *Setaria grisebachii*, *Tridens eragrostoides* and *Tridens muticus* and cultivated *Cenchrus ciliaris* and *Rhynchelytrum repens*. Grasses were collected by hand as encountered in four sites, randomly located, in a rangeland (900 ha) grazed by beef cattle at General Teran County, Nuevo Leon, México. Mineral concentrations were estimated using an atomic absorption spectrophotometer with an air/acetylene flame. The P content was determined in a colorimeter. All minerals, in all grasses, were significantly different between seasons and between grasses within seasons. In general, during wet seasons all grasses had higher mineral content. In all plants, in all seasons, K (overall mean = 12.0 g kg⁻¹ DM), Mg (1.8 g kg⁻¹ DM), Fe (129.0 mg kg⁻¹ DM), Mn (40.0 mg kg⁻¹ DM) and Zn (49.0 mg kg⁻¹ DM) were higher to meet growing beef cattle requirements; however, P (1.2 g kg⁻¹ DM), Na (0.3 g kg⁻¹ DM) and Cu (4) were lower. The Ca (5.0 g kg⁻¹ DM) was higher only in wet seasons (summer and autumn). Grazing cattle in these regions have to be supplemented with P, Na and Cu throughout the year and with Ca in dry seasons.

Keywords: Macrominerals, microminerals, cattle, native Mexican grasses, northeastern Mexico

Diversification in the Use of the Seeds of Five Soil Nitrogen Enriching Tropical Plants Used on Marginal Lands for Livestock Production

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The seeds of five plants (*Enterolobium cyclocarpum*, *Mucuna pruriens*, *Centrosema pubescens*, *Lablab purpureus* and *Gliricidia sepium*) which are normally used for nitrogen enrichment in marginal soils were harvested. Their chemical, antinutritional factor (ANFs) and amino acid compositions were determined. The aim is to promote the use of the seeds for livestock production. Samples of the seeds were sun-dried and milled. A portion of the milled samples was subjected to wet heating by autoclaving. The proximate, mineral, total phenols, tannin, phytic acid, L-dopa, cyanide and amino acid compositions were analysed. The highest crude protein was in *G. sepium* (498 g kg⁻¹) followed by *M. pruriens* (278 g kg⁻¹). The lowest crude protein was in *M. esculenta* with 209 g kg⁻¹. The crude fibre in *E. cyclocarpum* was the highest with 131 g kg⁻¹ while *G. sepium* and *C. pubescens* had the lowest crude fibre with 92 g kg⁻¹ each. Total phenols, tannin and L-dopa were significantly higher in *M. pruriens* with levels of 30.4, 7.1 and 13.2 g kg⁻¹, respectively. The highest levels of phytic acid and cyanide were present in *G. sepium* with 14.8 and 7.6 g kg⁻¹, respectively. There were remarkable reductions in the levels of the ANFs in the seeds after autoclaving. Of the total phenols 71, 62, 73 and 80 % of the total phenols in the *M. pruriens*, *L. purpureus*, *C. pubescens* and *G. sepium*, respectively was eliminated. Of the essential AAs, the levels of methionine, threonine and lysine in the seeds were lower than reported levels in soy bean meal. The levels of valine, leucine, isoleucine and histidine were comparable to those in soy bean meal. The level of histidine in *G. sepium* was much higher than in soy bean meal. Based on the FAO/WHO scoring pattern, methionine was the first limiting amino acid in all the seeds.

Keywords: Diversification, livestock production, seeds, soil nitrogen enrichment plants

Processed Kidney Bean (*Phaseolus vulgaris*) in Broiler Feeding — Performance Characteristics

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The effects of cooked and decorticated kidney bean (*Phaseolus vulgaris*) on performance characteristics of broilers were studied. A total of 120 one day old Abor-Acre broiler chicks was used for the study. The birds were randomly allotted to six dietary treatment groups with two replicate per treatment and ten birds per replicate in a completely randomised design. The processed kidney beans were used to replace two conventional protein sources: soybean meal (SBM) and groundnut cake (GNC), at 50 % level protein for protein in a 42 days feeding trial. Significant differences ($p < 0.01$) were observed in feed intake and weight gain ($p < 0.05$) across dietary treatments. Birds fed SBM - processed kidney beans diets had lower Feed: Gain ratio than birds fed sole GNC-based diet. This indicated a better feed utilisation by birds fed SBM - processed kidney beans diets. Protein Efficiency Ratio (PER) was not significantly ($p > 0.05$) increased in diets that contained processed kidney beans. However PER was lowest in diets that contained decorticated kidney beans compared to values obtained for cooked kidney beans diets and the control diets. Nutrient digestibility results showed significant differences ($p < 0.05$) across dietary treatments for crude protein, ether extract and crude fibre digestibility. Crude protein digestibility (49.50) was lowest in birds fed decorticated kidney beans.

It appeared that protein digestibility was not improved in spite of the removal of the testa which is the main tannin reservoir of the bean. This observation may be due to the presence of other anti-nutritional factors (including tannin) in the cotyledons. Cooking resulted in denaturing the heat labile anti -nutritional factors. Although decortication involved soaking in boiled water for a period of time, however the effect was not adequate to denature the heat-labile anti-nutritional factors compared to cooking.

A 50 % level protein for protein replacement of SBM with cooked kidney bean gave performance that was equally as good as feeding either sole SBM or GNC. Cooking was a better processing method for kidney bean compared to decortication.

Keywords: Broiler feeding, conventional protein sources, performance characteristics, kidney beans, *Phaseolus vulgaris*

Effects of Feeding Desert Locust Meal (*Schistocerca gregaria*) on Performance and Haematology of Broilers

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Locust and grasshoppers have been some of the greatest agricultural pests since the beginning of civilisation. Plagues of locusts devastate crops, pastures, orchards and entire countries or even continents. At unpredictable intervals locust invasions occur, with swarms moving into neighbouring areas of Africa, Asia and Europe and occasionally beyond. Despite this fact however, locusts could have beneficial effects as a source of protein in animal nutrition like some other insects.

A study was conducted to determine the effect of replacing fishmeal with desert locust meal at 0%, 1.7%, 3.4%, and 6.8% as replacement for the equivalent protein supplied by fishmeal in the control diet of a broiler experiment, on their performance from day-old till the end of starter phase (0–28 days). Diets were formulated to contain 2980 kcal ME and 23% crude protein at the starter phase. Ninety-six day-old unsexed broiler chickens (Abor acre) were randomly distributed to the four diets.

The treatments had no significant ($p > 0.05$) effects on the weight gain, feed intake, feed conversion ratio (FCR) and the haematology of the birds.

However, the best result was obtained in the treatment with 50% replacement of fishmeal with desert locust meal. The average weekly feed intake, weight gain and feed conversion ratio (FCR) for the treatment with the best result were: 1090 g bird⁻¹, 561 g bird⁻¹ and 1.9 respectively as compared to 957 g bird⁻¹, 457 g bird⁻¹ 2.1 for the control at the starter phase.

Furthermore, the result of the average live weight, plucked weight and eviscerated weight for the same treatment were: 2360g, 2155g and 1700g respectively, which were not significantly different ($p > 0.05$) from those obtained for the control at the end of the finisher phase. This showed that replacing half the fishmeal in the control diet with locust meal gave better body weight gain, feed intake and feed conversion ratio.

The results of this experiment therefore, indicated that desert locust has great potential as a protein source in broiler starter diets without causing any physiological disorder as reflected in the haematological analysis.

Keywords: Haematology, chicken performance, broiler, locust meal

Effects of Roxazyme -G on Growth Indices and Haematological Variables of Broilers Fed Maize Offal-Based Diets

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Influence of roxazyme -G on the utilisation of maize offal in place of maize was investigated using 420 broiler chicks. Seven diets were used in which the control diet (diet 1) contained 529 g kg⁻¹ and 569 g kg⁻¹ maize at starter and finisher phases, respectively. In diets 2, 3 and 4, twenty five percent of the maize components of diet 1 were replaced with maize offal while in diets 5, 6 and 7, fifty percent maize component of diet 1 was replaced with maize offal. Roxazyme-G was added to the diets at levels of 100, 200 and 300 mg kg⁻¹ in diets 2 & 5, 3 & 6 and 4 & 7, respectively. At the close of the starter (2–4 weeks of age) and finisher (5–8 weeks of age) phases 5 chicks and 5 chickens per replicate, respectively were sacrificed conventionally and their blood collected for blood analysis. Only the final weight of chicks were significantly ($p \leq 0.05$) influenced while growth indices were not in finished birds. The entire haematological indices measured were not significantly ($p \geq 0.05$) influenced by dietary treatment in both starter and finisher birds. At starter phase, the optimum level of maize offal substitution for maize could be achieved at 132.3 g kg⁻¹ + 200 mg kg⁻¹ roxazyme -G while 142.3 g kg⁻¹ maize offal + 200 mg kg⁻¹ roxazyme -G was the optimum level for finisher birds. Conclusive, the use of maize offal and roxazyme -G at these optimal levels could lead to more of maize offal being included in broiler diets in tropical countries.

Keywords: Blood indices, broilers, broiler feeding, roxazyme -G

Sustainable Utilisation of Cassava Plant for Feeding Monogastric Animals

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Studies were conducted to evaluate the effect of inclusion of various products and by products obtainable from cassava in a single or composite diet on the growth response of monogastric animals.

Cassava plant meal (CPM) which had about 9 % crude protein (CP) comprising unpeeled tubers, leaves and tender-stems was developed. Growth studies which lasted eight weeks with rabbits and pigs, sixteen weeks with cockerels and four weeks with broilers were conducted. In the broiler study, a basal diet of 22% CP was formulated with 50 % maize for 153 one week old broiler chicks. The maize was replaced with CPM at rates 0, 25 and 50 % of maize. In the study with rabbits, a basal diet of 15% CP was formulated with 45 % maize for ten-week old rabbits. The maize was replaced with CPM at rates 0, 50 and 100 % of maize. In the study with cockerels, a basal diet of 16% CP was formulated with 45 % maize for 150 day old cockerel chicks. The maize was replaced with CPM at rates 0, 50 and 100 % of maize. In the study with pigs, a basal diet of 18% CP was formulated with 40 % maize sixteen weeks old pigs. The maize was replaced with CPM at rates 0, 50 and 100 % of maize.

In the study with broilers, the growth rate decreased and feed to gain ratio deteriorated ($p < 0.05$) as the proportion of the CPM in the diet was increased. In the study with pigs, the daily gain, feed intake and feed/gain ratio were not significantly ($p > 0.05$) influenced by the inclusion of CPM to replace maize. In the study with cockerels, daily gain and feed/gain ratio were significantly ($p < 0.05$) affected when CPM replaced maize in their diets. The inclusion of CPM to replace maize in the diets of growing rabbits resulted in better ($p < 0.05$) daily gain, feed intake and feed/gain ratio.

Findings from the above studies suggest the suitability of CPM to replace maize completely in the diets of pigs and rabbits while partial replace of maize with CPM gave satisfactory performance with broilers and cockerels.

Keywords: Broilers, cassava, cockerels, daily gain, pigs, rabbits

Utilisation of Cassava Peel Based Diet Supplemented with or without Farmazyme® 3000 Proenx by Growing Pigs

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The utilisation of cassava peel based diet supplemented with or without Farmazyme® 3000 Proenx multi-enzyme (fungal xylanase, fungal β -glucanase, endo β -glucanase, α -amylase, β -glucanase (pH 7.5, 30°C), β -glucanase (pH 5, 30°C), hemicellulase, pentosanase and pectinase) as a replacement for maize in diets of growing pigs was investigated using 36 growing pigs (average initial weight of 22.74 ± 0.88 kg). The pigs were allotted to three dietary treatment groups. of (1) 30%-Maize based control diet, (2) 30%-cassava peel based diet and (3) Farmazyme® 3000 Proenx supplemented 30%-cassava peel based diet. Each treatment had three replicates of 4 pigs replicate⁻¹ (12 pigs treatment⁻¹) in a complete randomised design. The pigs were allowed ad libitum access to the diets and water throughout the 42-day duration of the trial.

The replacement of the 30 % maize in the control diet with cassava peel resulted in increased bulkiness and crude fibre contents of the cassava peel-based diets, hence, lowered energy content. There was also a reduction in the dry matter intake of the pigs and the cost of feed per kg by 19.6 % and 23.5 % for the cassava peel based diet with and without Farmazyme® inclusion respectively. The replacement of the maize content of the control diet with cassava peel resulted in 23–24 % reduction in the cost of feed per kg live weight gain of the growing pigs. Farmazyme® resulted in enhanced utilisation ($p < 0.05$) of the cassava peel-based diet in terms of the daily and overall weight gains as well as the serum total protein, albumin, urea and cholesterol. While the haemoglobin and RBC of the pigs were significantly positively influenced by the inclusion of the enzyme, it had no effect on the PCV. The blood minerals (Na, Ca, Cl and P), relative organ weights and dressing percentage of the pigs were neither affected by the cassava peel replacement nor the enzyme inclusion but for the kidney, where lower values were obtained both for the control and Farmazyme® supplemented cassava peel-based diets. It could therefore be concluded that inclusion of Farmazyme® 3000 Proenx enhanced utilisation of the cassava peel-based diet thereby resulting in performance results comparable to pigs fed the maize-based control diet.

Keywords: Cassava peel, enzyme utilisation, nutrient utilisation, pig performance

Dried Betel Vine (*Piper betel* Linn) Leaves as Feed Additive in Weaning Pig Diets

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This study was conducted to evaluate the effect of using dried betel vine (*Piper betel* Linn) leaves as a feed additive in weaner pig diets. Sixteen weaner pigs, 28 days old, averaging 9.85 kg, were randomly divided into four groups of four animals each. Each group was allocated to one of four dietary treatments in a completely randomized design: 1. Control basal diet, 2. Basal diet supplemented with dried betel vine leaves at 0.5 %, 3. Basal diet supplemented with dried betel vine leaves at 0.75 % and 4. Basal diet supplemented with 1 % probiotic. Feed intake, weight changes and fecal characteristics were recorded over 35 days. Average daily gain (ADG) across treatments were respectively 588, 590, 571 and 548 g day⁻¹. Respective feed conversion ratios (FCR) were 1.66, 1.46, 1.40 and 1.30. There were no significant differences ($p > 0.05$) in ADG across the treatment groups. The pigs on the probiotic dietary supplementation treatment had significantly ($p < 0.05$) better FCR compared to the control group. However, this was not significantly ($p > 0.05$) different from the pigs supplemented with 0.5 and 0.75 % dried betel vine leaves. Faecal score and faecal colour from the pigs on 0.5 and 0.75 % dried betel supplementation were significantly better ($p < 0.05$) than those of the pigs in the control group and probiotic supplemented group. Furthermore, the pigs supplemented with 0.5 and 0.75 % dried betel exhibited less scouring incidence. It can be concluded that dried betel vine leaves can be included as a feed additive in weaner pig diets to decrease incidence of scours and has no detrimental effect to weaner pig growth and feed conversion efficiency.

Keywords: ADG, betel vine, FCR, faecal colour, faecal score, probiotic, weaning pig diet

Antibacterial Activity of Crude Extracted Betel Vine Leaf Against *Salmonella* spp.

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Betel leaf is an important component of daily consumption in Asia and Africa. Betel leaf constituents volatile oil (cadinene, carvacrol, caryophyllene, chavibetol, chavicol, 1,8-cineole, estragole, eugenol, terpinyl acetate, etc.), amino acids, pyridine alkaloids, sitosterols, stigmasterol, tannins, vitamin C, oxalic acid, d(+)-malic acid, n-hentriacontane, n-pentatriacontane and inorganic elements (fluoride, iron). The volatile oil from the betel leaf extract is antiseptic and antioxidant. The aim of this study was to determine the *in vitro* antibacterial activities of crude extracted betel vine leaf against *Salmonella* spp. A total of 300 g crude extract was extracted from 2 kg fresh betel vine leaf (15 % yield) by 95 % ethanol. Fourty eight samples of pig feces (n=16), pen floor (n=3), sewage (n=3), water (n=2) and pork (n=24) were treated with several concentration (0.0061 to 6.25 $\mu\text{l ml}^{-1}$) of the betel vine leaf extracted in Mueller Hinton Agar (MHA). The minimal inhibition concentration (MIC) of the extracted was lowest in 4.2 % of pork samples (0.0244 $\mu\text{l ml}^{-1}$ for *S. rissen*) whereas highest in 18.75 % of fecal samples (1.5625 $\mu\text{l ml}^{-1}$ for *S. krefold*). At 0.3906 $\mu\text{l ml}^{-1}$ showed the antibacterial activities of 2 strain *Salmonella* spp. (*S. rissen*, *S. lagos*) in 45.8 % of pork samples and at 0.7812 $\mu\text{l ml}^{-1}$ showed the broad antibacterial activities of 8 strain *Salmonella* spp. (*S. rissen*, *S. lagos*, *S. krefold*, *S. weltevreden*, *S. Stanley*, *S. derdy*, *S. salamae*, *S. bovisorbifican*) in all type of samples (100 % of sewage, pen floor and water, 81.25 % of feces, 50 % of pork). We further intend to determine effective constituents in betel leaf and use the crude extracted as feed supplement in weaned pig diets for controlling diarrheal bacteria.

Keywords: Antibacterial activity, crude extracted betel vine, *Salmonella* spp.

Preliminary Observations on some Haematological Parameters of Juvenile *Heterobranchus longifilis* Fed Different Dietary Levels of Raw and Boiled Jackbean (*Canavalia ensiformis*) Seed Meal

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Given the unavailability and high cost of fishmeal particularly in developing countries, an aggressive search ensued for cheap and quality alternatives to fishmeal. Neglected novel legumes which abound in the tropics have been evaluated. Jackbean (*Canavalia ensiformis*) is one of such legumes with a crude protein and amino acid profile that recommend it for use as alternative protein source. It is readily available and hardly consumed by man. It however, has some anti-nutritional factors some of which can be reduced to a very large extent by processing. This work is designed to study the effect of feeding raw and processed jackbean seed meal (JBSM) at different dietary levels on some haematological parameters of *Heterobranchus longifilis* bearing in mind that haematology can be employed to assess fish health. Two types of JBSM were obtained by milling the raw seed with hammer mill and subjecting a portion of the milled bean to boiling for 60min. Thirteen isonitrogenous (CP 30%) and isocaloric (ME 2900 kcal kg⁻¹) diets were formulated. Diet 1 without JBSM served as control. Diets 2, 3, 4, 5, 6 and 7 had the fishmeal component replaced progressively by raw JBSM at 10%, 20%, 40%, 60%, 80%, and 100% respectively. In diets 8, 9, 10, 11, 12 and 13 60min. boiled JBSM replaced fishmeal at 10%, 20%, 40%, 60%, 80% and 100% respectively. Test diets were assigned randomly to duplicate groups of 20 fish (average total length 18 cm) in 20 litre plastic aquaria. Juvenile *H. longifilis* were fed raw and 60 min. boiled JBSM at different dietary levels for 56 days. Evaluation of some of the haematological parameters showed that haematocrit (PCV), red blood cell (RBC) count, white blood cell (WBC) count, haemoglobin (Hb) concentration and lymphocytes decreased significantly ($p < 0.05$) with increasing dietary level of JBSM. Boiling JBSM for 60min slightly improved the quality such that fish fed diets with 10% fishmeal substitution had similar PCV and WBC count to those fed the control diet. Other measures to improve the quality of boiled JBSM protein are suggested to enable its use in place of fishmeal at moderate dietary levels in fish production.

Keywords: African catfish, *Heterobranchus longifilis*, alternative protein source, fishmeal, haematology, Jackbean, *Canavalia ensiformis*

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Proximate and Mineral Composition of *Parachanna obscura* Juveniles Exposed to *Derris elliptica* Root Powder

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Many plants contain chemicals which have traditionally been used to harvest fish in almost all parts of Nigeria. The use of toxicants is essential for controlling fish predators. For example, *Derris elliptica* root extracts act as toxicant when used in water bodies and fish culture enclosures in Nigeria. It is one of indigenous sources of fish toxicant in Nigeria. It is known that fish farmers have persistently and indiscriminately abuse *D. elliptica* by using far more than required concentration and thereby causing mass mortality of target, non-target and affecting histological properties of the fish. *Parachanna obscura* juveniles were assessed for proximate composition with a view to establish the nutritive value of *D. elliptica* on fish species. Muscle samples were taken from fish and body composition (% protein, % fat, % moisture and % ash) was determined. Analysis of the muscle revealed that the mean of all the proximate and mineral composition of *P. obscura* juveniles exposed to *D. elliptica* root extracts were 0.70 % moisture, 9.23 % protein, 0.78 % lipid, 32.44 % ash and, 45.63 % NFE while the mean values of Zn, Ca, Mg and Cu composition of the test fish were 987.97, 1789.33, 1583.63 and 30.62 respectively. The technological implications of this analysis on the test fish are discussed. The sizes and sex of the fish species did not significantly affect the proximate composition of their flesh. If adequately used the toxicant would result into increased food production since it constitutes a significant aide to local fish farmers although its effect on the health of the consumers is yet to be fully investigated.

Keywords: *Derris elliptica*, *Parachanna obscura*, proximate composition

Growth and Feed Conversion of the Grass Carp (*Ctenopharyngodon idella*) Fed on Fresh Plant Material under Laboratory Conditions in Viet Nam

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In many Asian regions, the cyprinid grass carp (GC) play an important role in the livelihood of rural poor, e.g. in Sonla - a mountainous province in Viet Nam. Cyprinids are by far the largest group of cultured fish throughout the world. However, despite the high worldwide share and an enormous importance for the nutrition and income of rural poor, so far only few data have been published on the utilisation of plant leaves and different tropical grasses by GC. In the presented study, growth rates and feed conversion of GC fed on banana leaves (BL; *Musa* sp.), napier grass (NG; *Pennisetum purpureum*) and barnyard grass (BG; *Echinochloa crusgalli*), all being frequently used as fish feed in Viet Nam, are determined under controlled laboratory conditions. 60 fish (~22 g per fish) were divided into 3 feeding groups (4 fish per aquarium, 5 replicates). Pre-weighed BL, BG and NG were fed to fish *ad-libitum* for 8 weeks. Feed leftovers were removed, dried and subtracted from the feed applied (dry matter, DM). Proximate composition and gross energy (GE) of fish and feed were determined according to AOAC (2000) standards and by using a bomb calorimeter.

All feeds show a low crude protein ($\leq 15.4\%$ of DM) and crude lipid content ($\leq 5.9\%$ of DM) and have a high proportion of neutral ($\geq 48.8\%$ of DM) and acid ($\geq 28.8\%$ of DM) detergent fibre. In both grass-fed groups fish mortalities occurred and fish seemed to be weak. GC grew significantly better on BL with a weight gain of 89% as compared to 36% and 26% in the BG and NG group. The specific growth rate in the BL fed group was 1.0 ± 0.3 , the feed conversion ratio 5.5 ± 1.0 . The content of crude lipid and GE was significantly higher in those fish fed on the leaves as compared to the grass-fed feeding groups.

It can be concluded that all feeds applied seem to be poor feeds for small GC when fed alone. However, BL showed a potential to be used as feed ingredient in formulated GC diets.

Keywords: Banana leaf, barnyard grass, grass carp, napier grass

Validation of Essential Amino Acids Requirements of Red Tilapia (*O. mossambicus* × *O. hornorum*) Assessed by the Ideal Protein Concept

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“Red” tilapias have become increasingly popular in Egypt because of their hardness, fast growth rate and large size adults and their similar appearance to the marine red snapper which has a high market value. The objective of this study was to determine the amino acid requirements of the *O. mossambicus* × *O. hornorum* hybrid taking into account the empirically determined lysine requirements which had been estimated by the ideal protein concept. The determined values are compared with values in the literature.

Red tilapias were raised in 10 experimental concrete ponds with 3 replicates per pond. Twenty fish of fingerling size (5-10 g) per replicate were sampled from each experimental group for determination of whole body amino acids composition. Triplicate samples were oven dried at 105°C for 24 hours, finely powder and sieved. The amino acid composition was determined in acid hydrolysates (6 mol L⁻¹ HCl) by using the ideal protein concept (essential amino acid ratio). Data was statistical analyzed by correlation test (r) using SPSS Program.

The essential amino acid requirements in g kg⁻¹ protein were estimated as follows: arginine 40g, histidine 16g, isoleucine 26g, leucine 45g, methionine + cystine 35g, phenylalanine + tyrosine 49g, threonine 33g, tryptophan 8g and valine 30g. Except for higher leucine and lower phenylalanine + tyrosine, estimated requirements for the other essential amino acids were similar to the empirically determined essential amino acid requirements recorded in literature. Based on this data cost-effective diets can be prepared with a nutrient content balanced to suit the requirements of the hybrid *O. mossambicus* × *O. hornorum*. These data will be useful to achieve optimal growth of tilapias especially in the low technology fish production programs in different African countries.

Keywords: Amino acid requirements, ideal protein concepts, Tilapia

The Use of Enriched ^{15}N as an Indicator of the Assimilation of Fish Meal, Pea Seed Meal and Housefly Maggot Meal Protein in the Diet of *Oreochromis niloticus*

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For effective substitution of fish meal in new aquafeeds a complete evaluation of possible alternative feed ingredients should provide exact data related to their nutritional value, as well as digestibility of the main nutrients. Considering new methods in fish digestion studies we examined the potential of using an enriched stable isotope (^{15}N) to evaluate the digestibility and trace the assimilation of different dietary protein sources in the digestive tract of male *Oreochromis niloticus* ($49.9\text{g} \pm 25.2\text{g}$).

Fish meal and housefly maggot meal were used as sources of animal protein and pea seed meal as a source of plant protein. All three protein sources were labelled with ^{15}N before they were incorporated into three standard compound isonitrogenous flake diets (crude protein: $30.2\% \pm 0.3$ in dry matter). 40 experimental fish divided into four groups of ten individuals were all fed with one of the experimental diets at the same starting time. After 15 minutes, 2 hours, 4 hours, and 6 hours 3 fish were separated from the experimental fish groups and observed in detail. Whole stomach and gut were extracted from these fish as well as samples of liver, kidney, gills and filet. Taken samples were rapidly cooled down in liquid nitrogen and stored in a refrigerator for further investigations.

Laboratory observations for the presence of ^{15}N in experimental fish gave an interesting outlook on the digestion and assimilation of the different dietary protein sources. The results demonstrated that enriched stable isotope tracers can provide a comprehensive overview on the digestibility, absorption and assimilation of nitrogen from individual protein sources in compound diets for tilapia.

Keywords: ^{15}N , enriched stable isotope, *Oreochromis niloticus*, protein assimilation, protein digestion, tilapia, housefly maggot meal

Protein Concentrates for Animal Feedstuff Derived from Fly-Massproduction: *Hermetia-Meal* as an Alternative to Fishmeal

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Regarding the growing demand for fishmeal in the animal feed sector, the calls for alternatives are getting louder especially when facing decreasing fish stocks and fast growing prices for fishmeal. Looking for alternatives scientists recently were focussing on the possibility of mass-rearing of flies on organic manure. The fly *Hermetia illucens* occurring in warm countries all over the world (including the Mediterranean states and southern parts of Switzerland) seems to be an ideal candidate. This organism can be reared on animal manure and other agricultural wastes which have to be deposited on rather high costs, normally. The developing stages of this fly reduce the volume of those substrates by up to 50 % producing biomass with a protein content of about 43 % and a fat content up to 35 %. In the year 2006 a study on the technical and economical feasibility of the mass-production of *Hermetia* was conducted. The first European colony of *Hermetia illucens* was established and a series of substrate-tests was done as well as an economic extrapolation of possible production scenarios. A feeding trial on rainbow trout showed little decrease in feed conversion when replacing the diet's fishmeal with non-defatted *Hermetia-meal* to an extend of 50 %. Decrease was more substantial in the case of 75 % supplementation. Results are expected to become much better with de-fatting the meal and reducing the chitin content. Tests on the taste and quality of the filet did not show significant differences between the *Hermetia-fed* fishes and the controls. The cost-extrapolation showed that the production can be realised below the costs of fishmeal-production by using existing logistical structures and taking in account production volumes between 1,000 and 10,000 t per annum. Keeping in mind that the world-wide demand for fishmeal was about 6 million tons in the year 2005 production volumes in the above mentioned range will just be a small beginning.

Keywords: Fishmeal, *Hermetia illucens*, insect-proteins, feed protein demand

Towards Ecological Sustainability in (sub)tropical Animal Nutrition - Life Cycle Assessment as a Tool to Identify Environmentally Sound Feeding Options

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The increasing demand for animal products in developing countries presents opportunities, but also challenges to the socio-economic and environmental sustainability of animal production. Research concerning (sub)tropical animal nutrition has focused mainly on the optimisation of the nutritional properties of animal diets. However, especially in (sub)tropical regions, sustainability issues, such as soil conservation and biodiversity, should be considered thoroughly in order to maintain the alimentary basis of the local population in the long run. Life Cycle Assessment (LCA) is the internationally most accepted method to assess potential impacts to human health and the environment associated with a product, process or activity by evaluating resource consumption and emissions. In temperate zones, LCA has been applied to assess the environmental impact of different animal production systems, e.g. comparison of conventional and organic dairy systems or different animal diets. In (sub)tropical countries, there does not exist any LCA study concerning animal production. LCA studies in temperate regions and related LCA studies in (sub)tropical areas, however, provide a good basis for the application of LCA in (sub)tropical livestock nutrition, e.g. LCA studies on soy production in Brasil, which are available because soy bean meal is a European animal feed ingredient. In addition, LCA studies on bioethanol production in Mediterranean and tropical regions can provide useful data concerning the environmental burdens of crop cultivation, e.g. wheat and corn. These crops or their by-products are important supplements for livestock in (sub)tropical areas. Furthermore, LCA studies concerning irrigation-based fruit production can provide important basic information on the application of LCA in (sub)tropical environments. In order to be able to account for ecosystem services of agricultural and grazing land and to differentiate between extensive and intensive land use, consensus on how to include biodiversity in LCA is essential. To be able to identify environmentally sound animal diets in (sub)tropical regions, we therefore have to i) give an overview on existing publications concerning the use of LCA in (sub)tropical countries, ii) point out which factors have to be taken into account specifically when applying LCA in (sub)tropical animal nutrition, and iii) highlight the importance of including biodiversity in LCA studies.

Keywords: Food chain, integrated production, nature conservation, sustainable land use, water use efficiency

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Influence of Colour Type on the Concentration of Potential Fertility Enhancing Secondary Metabolites of the Andean Plant Maca (*Lepidium meyenii* Walp)

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Maca (*Lepidium meyenii*) is an ancient crop which grows best in the central Peruvian and Bolivian Andes between 3,800 and 4,500 m a.s.l. During the last decades, Maca has received and still receives much attention, this in particular because of its potential fertility effects. These effects are reported to vary between Maca colour types. The following secondary metabolites have been discussed to play an important role in the fertility-enhancing effect of Maca in humans and animals: glucosinolates, macaene, macamides, linoleic and linolenic acid, campesterol and β -sitosterol. The present study aimed at comparing the concentrations of the above mentioned compounds in crude and boiled Maca hypocotyls of four different colour types (yellow, red, black and violet). The Maca hypocotyls were collected on eleven farms in the regions of Pasco, Junin and Tarma (Departments of Pasco and Junin, Peru). The plant material collected was dried, milled, boiled and analysed with HPLC for the metabolites listed above. The glucosinolate content varied, ($p < 0.001$) between different colour types. Total glucosinolate contents ($\mu\text{mol g}^{-1}$ DM) of red (17.9) and violet (17.3) Maca hypocotyls were higher ($p < 0.05$) than that of yellow (13.3) and black (10.8) Maca. Boiling reduced ($p < 0.001$) the contents of the glucosinolates in Maca hypocotyls. The highest linoleic (1.34 mg g^{-1} DM) and linolenic acid contents (1.03 mg g^{-1} DM) were found in red Maca, the highest Macaene (1.42 mg g^{-1} DM) and β -sitosterol (0.43 mg g^{-1} DM) contents in yellow Maca and the highest Macamide 1 (N-benzyl palmitamide) (0.60 mg g^{-1} DM) content in Violet Maca. Black Maca contained the lowest amounts of macaene, linolenic acid and β -sitosterol. Macamide 2 (N-benzyl-5-oxo-6E, 8E-octadecadienamide) and campesterol did not significantly differ among colour types. In most metabolites the farm effect was very distinct, which means that there are factors other than colour type such as duration of fallow, date of plantation, date of harvest and post-harvest treatment, such as drying technique, which might affect the contents of these compounds, thus presumably influencing the effect of Maca on fertility. Since the colour type of the Maca hypocotyls exerted this strong influence metabolite concentration, a different activity in improving human and animal fertility can be expected.

Keywords: Colour types, Fertility, Glucosinolates, *Lepidium meyenii*, maca, Secondary compounds

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Feed Intake of Supplemented Goats on Communal Pastures in the Al Jabal al Akhdar Mountains, Northern Oman

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Goat husbandry is an important activity in the agro-pastoral systems of the Al Jabal al Akhdar mountains in northern Oman, supplying food, income and manure to farm households. Farmers cultivate fodder crops such as maize, barley and alfalfa; in addition they offer purchased supplements, including dates, fish and barley grain to the animals at the evening feeding. During the day, the goats graze the natural vegetation on the communal pastures surrounding the villages.

To determine the total organic matter (OM), nitrogen (N), phosphorus (P) and metabolisable energy (ME) intake of goats and identify the contribution of the natural vegetation, a study was conducted in three villages of the Al Jabal al Akhdar mountains during October - December 2005. The quantity of faeces excreted daily was determined in 8 male goats per village using the external marker TiO_2 , and overall diet digestibility was calculated from the concentration of crude protein in faecal OM. The amounts of feeds ingested at the homestead were determined by weighing offer and refusal during the 7-day experimental period.

Goats' daily OM intake on pasture accounted for 47 % - 71 % of total OM intake (88 -107 g $\text{kg}^{-0.75}$), indicating the strong reliance of goat husbandry on the natural vegetation. However, since energy and nutrient concentrations, were low in the pasture plants, feed intake of goats during grazing provided only 51 % - 65 % of the total N intake, and the daily intake of ME (741 kJ $\text{kg}^{-0.75}$, SD 125.3) and of P (104-133 mg P $\text{kg}^{-0.75}$) were mainly based on the supplements offered. While P intake was below the recommended maintenance values, ME intake covered maintenance requirements but appeared to be insufficient for growth and production. However, intake values determined shortly after heavy rainfall in April 2005 suggest that nutrient and energy deficiencies might be restricted to periods of the year when the nutritional quality of the pasture vegetation is low. Moreover, nutrient requirements of the local Jabal Akhdar goat might differ from temperate breeds for which requirements have been established. The productivity of the local breed under the feeding practices of farmers on the Al Jabal al Akhdar should therefore be studied in more detail.

Keywords: Al Jabal al Akhdar, faecal marker, goats, grazing, feed intake, Oman

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Outbreak of Morels Disease (Sheep Abscess disease) in the Sudan

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We report here an outbreak of abscess disease in a flock of sheep in Al Samra village, Khartoum North, Sudan. The flock consisted of 100 animals of different ages ranging from 4 - 12 months. The animals were free grazing during the daytime and they were kept in a pen at night, where they receive some type of feed supplemented with concentrates. Thirty animals were showing one or two abscess of superficial (prescapular or parotid) lymph nodes. Abscesses were round with diameter of 4 - 10 cm, soft in consistency when palpated. All abscesses were incised following aseptic procedures (shaving, rubbing with tincture of iodine and 70% alcohol) and the contents were expelled from which samples were taken in sterile containers. The contents of almost all abscesses were odourless, viscid, yellowish white to creamy in colour and were enclosed in a thick connective tissue capsule. Bacteriological examination of the contents of abscesses of 28 (93.33%) animals revealed pure cultures of Gram-positive cocci arranged in pairs, tetrads and clusters. Biochemical tests for these bacteria were typical to those of *Staphylococcus aureus* subspecies *anaerobius*, the aetiological agent of sheep abscess disease, which was firstly described by Morel in 1911 in France. Abscesses of the remaining two animals yielded growth of *Corynebacterium* spp., the causative agent of caseous lymphadenitis of sheep. Results of this report confirm findings of previous investigations on abscess syndromes of sheep in the Sudan, in which *Staph. aureus* subsp. *anaerobius* was found to be the first organism to be incriminated in superficial lymph node abscess in sheep, especially of small ages and in sheep in steaming up operations.

Keywords: *Corynebacterium* spp., Morels Disease, sheep abscess, *Staphylococcus aureus*

Collaborative German-ILRI Research to Discover New Diagnostic Tools for Contagious Bovine Pleuropneumonia, the Most Devastating Cattle Disease in Africa

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Contagious Bovine Pleuropneumonia (CBPP) is an acute pneumonia of cattle caused by the bacterial pathogen *Mycoplasma mycoides* ssp. *mycoides* small colony type (MmmSC). The African Union considers CBPP as the most important cattle disease in Africa after eradication of Rinderpest. CBPP severely affects cattle stocks in Africa and consequently a large proportion of the livestock-dependent population. While the disease has been eradicated in most parts of the developed world it is still present in all countries of Sub-Saharan Africa. After initially successful control measures in the 1960s CBPP has been spreading due to a lack of money, fragmentation of veterinary services, uncontrolled cattle movement, poor vaccine efficacy, and poor sensitivity of current diagnostic tests. The current diagnostics are only able to detect CBPP during the acute phase of the disease and cannot detect chronically infected animals, which are responsible for perpetuation and for introduction of CBPP in previously uninfected herds. A diagnostic test able to detect chronically infected animals would be a key tool in controlling CBPP. By having such a test, stakeholders would be able to test their cattle stock for CBPP, separate infected animals, and ensure that only CBPP-free animals are traded. This would not only help to secure a constant income from trade, but also increase livestock productivity. In addition, improved diagnostic tests would be highly relevant for the European Union in case CBPP is re-introduced into livestock of member states. In order to develop new diagnostic tools and vaccines suitable MmmSC immunogenic proteins must be identified. To this end, MmmSC whole cell proteins were separated by two-dimensional (2D) PAGE, and sera collected from infected zebu cattle were pooled and used in Western immunoblot. Immunogenic proteins were then identified by mass spectrometry. Further a peptide spot array analysis was used to detect immunogenic epitopes of membrane-associated lipoproteins, which were previously recognised by in-silico analysis of the genome sequence of *Mycoplasma mycoides* ssp. *mycoides* PG1. The combination of both methods allowed the identification of several immunogenic MmmSC proteins for potential use in advanced diagnostics. These proteins will now be further analysed for their potential as diagnostic antigens.

Keywords: CBPP, cattle disease

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Socio-Economic and Ecological Analysis of the Use of Controlled Fires in Pastoralism: Cases of two Agroecological Zones of Benin

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The studies of social acceptability, technical feasibility, economical profitability and ecological effects of the controlled fires use were conducted in two agro-ecological zones of Benin. Objectives were: (i) to test the effects of various controlled fires on the grasslands productivity and quality; (ii) to make a comparative socio-economic analysis of the controlled fires use and the establishment and utilisation of artificial pastures. Socio-economic data were collected through surveys with small breeders, farmers, and managers of pilots' ranches of the "Projet de Développement de l'Élevage au Bénin". Three types of vegetation fires (early fires, late fires and out-of-season fires) were tested. The use of phytosociological and linear surveys results in the typology and determination of pastures pastoral values. Phytomass was harvested inside and outside protected plots.

Pastures respond differently to various types of fires. Early fires significantly improve productivity with a coefficient of improvement of 18.2 % in Sudano-Guinean zone and 24.4 % in Guineo-Sudanian zone.

Pasture productivities were low in response to both late and out-of-season fires in both guineo-sudanian and sudano-guinean zones. The coefficient of productivity reduction ranged from 10.0 to 20.1 % for the late fire and 26.2 to 50.3 % for the out-of-season fire. Both early and late fires improve the pastoral values in the two zones. The average values were 51.2 % and 50.7 % respectively for early and late fires. Conversely, the out-of-season fires decreased this value in the magnitude of 9 %.

Fires are used in Benin for economic, ritual and hygienic reasons. Their application on natural pastures is relatively more profitable than producing artificial pastures. Establishing and maintaining 1 hectare of artificial pasture requires 306.76 \$US/ha/year while managing a natural pasture by fire costs 11.43 \$US/ha in the first year and approximately 4.82 \$US the four last years. Globally, managing a natural pasture by fire is more profitable than producing an artificial pasture which requires investments that small breeders and farmers cannot afford to do with their small resources. Controlled fires might improve the natural pastures productivity and could be recommended in the current degradation context of natural pastures in Benin.

Keywords: Agroecological zone, analyze, Benin, controlled fires, ecological, socio-economic

Livestock and fodder production systems

Invited Paper	49
AKKE VAN DER ZIJPP: Livestock and Livelihood Systems in the Face of Global Change	49
Oral Presentations	50
JOLLY KABIRIZI, DENIS MPAIRWE, DAVID MUTETIKKA: The Effect of Integrating Forage Legumes in Smallholder Crop/Livestock Farming Systems on Food, Fodder and Animal Performance	50
ALCIDO ELENOR WANDER, TIAGO RIBEIRO RICARDO, PRISCILA DE OLIVEIRA, PEDRO MARQUES DA SILVEIRA: Economic Viability of Crop Livestock Integration under Irrigated Conditions in Goiás State, Brazil	51
YITAYE ALEMAYEHU AYENEW, MARIA WURZINGER, AZAGE TEGEGNE, WERNER ZOLLITSCH: Urban and Peri-Urban Farming Systems and their Utilisation of the Natural Resources in the North Ethiopian Highlands	52
Posters	53
TIN AUNG, STEPHAN WESSELS, GABRIELE HÖRSTGEN-SCHWARK: Investigations on Rice-Fish Culture in Myanmar	53
PETER LENTES, FEDERICO HOLMANN, MICHAEL PETERS, DOUGLAS WHITE, H. CRUZ: Dry Season Resource Use Efficiency of Cattle Farms in Olancho, Honduras and Implications for Forage Technology Adoption	54
EL TAHIR SALIH SHUIEP, IBTISAM E. M. EL ZUBEIR, OSMAN ALI EL OWNI: Influence of Season and Management on Composition of Raw Camel (<i>Camelus dromedarius</i>) Milk in Khartoum State, Sudan	55
HABIBULLAH BAHAR, TARIKUL ISLAM, MONIRUL ISLAM: Evaluation of Lac Cultivation in two Southwestern Districts in Bangladesh	56

KARIN BARTL, CARLOS A. GOMEZ, HANS-DIETER HESS, ANDREA CORINNA MAYER, MICHAEL KREUZER, FEDERICO HOLMANN: Costs and Benefits of Traditional and Improved Dry Season Feeding Systems of Dairy Cattle for Smallholder Farmers in the Peruvian Andes	57
ELSA SÁNCHEZ, WERNER DOPPLER: From Subsistence to Market Oriented Livestock Smallholders Development in Nicaragua and Honduras	58
JOHN DAVID KABASA, F. EJOBI, F. EBONG, P. ISABIRYE, JOLLY KABIRIZI: Implications of Climate Change Clean Development Mechanisms on Livestock Agricultural Modernisation in Africa: Case Studies in Uganda	59
WIRAT KRASACHAT: Economic Efficiency of Feedlot Cattle Farms in Thailand	60
CHRISTOPH REIBER, RAINER SCHULTZE-KRAFT, MICHAEL PETERS, VOLKER HOFFMANN, CARLOS LASCANO: Potentials and Constraints of Little Bag Silage in Honduras	61
LOK NATH PAUDEL, MATTHIAS GAULY, UDO TER MEULEN, CLEMENS WOLLNY: Gender Role, Present Situation, Constraints and Opportunities: Is it a Challenge for Livestock Research and Development in Nepal?	62
NORMAN GERHARDT, CHRISTIAN HÜLSEBUSCH, MICHAEL WACHENDORF: Yield Development and Quality Changes of High Yielding Grasses During the Rainy Season in the “Natural Reserve Area Chacocente” on the Nicaraguan Pacific Coast	63

Livestock and Livelihood Systems in the Face of Global Change

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Many drivers of change effect livestock systems. These drivers act at different levels: farming system and livelihood, regional within or across countries and international or global. The challenge for understanding the effects of drivers of change is to study the drivers and response to change at different levels and analyse (in)coherence between levels from the lowest to the highest system level or vice versa.

As global change is a complicated matter numerous questions can be asked. Does the livestock revolution have positive effects for all primary producers? Are the opportunities of international trade agreements creating open borders really positive for developing countries for all agricultural products or is the balance tipping to consumers in the developed countries? How does climate change effect livestock producers and in particular their feed resources? What is happening to soil fertility and feed availability when biomass production for fuel becomes an interesting enterprise? Does the societal demand for better animal welfare in Northwest Europe influence global standards and can farmers adapt to the requirements for housing, health and transportation? Do farmers have sufficient capabilities to respond to the quality standards for retail marketing? The global dynamics cover economic, social, political and ecological aspects of animal production and food chains and influence the sustainable development at all system levels.

At the local level farmers face their endowments like natural resources in terms of land and its fertility, water, crop and animal genetics, and labour availability of the household, capital investment, marketing and infrastructure, farmers associations and social networks. Each of these components of the farming system and the household determine the response to change. Moreover opportunities for better paid work outside the farming system maybe more attractive.

A major problem is to understand the effects of the global drivers in the local situation, but also at the regional, national and international level. Integration of these drivers at these levels is an even more difficult task.

In this paper I will present global drivers and responses and link these to the roles of livestock of smallholders. What is their perspective in response to global drivers?

Keywords: Global drivers, smallholders, sustainable development

The Effect of Integrating Forage Legumes in Smallholder Crop/Livestock Farming Systems on Food, Fodder and Animal Performance

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In a farmer participatory process, farmers in Uganda identified intensive dairy cattle farming based on improved breeds and Napier grass (*Pennisetum purpureum*) basal forage as a potentially viable enterprise to enhance income of resource poor households. Inadequate year-round fodder supply partly due to land shortage is a major constraint in this production system. Napier grass productivity declines during the dry season resulting in a decline in animal performance and household income. To alleviate this concern, a participatory on-farm study on maize/*Lablab purpureus* (lablab) intercropping was done to evaluate the effects of intercropping lablab with maize crop on stover and maize grain production and document farmers' experiences in testing food/forage technologies.

The study results showed that fodder dry matter and maize grain yields and cob size were increased by 26, 7 and 6 %, respectively in maize/lablab intercropping systems compared to maize monocrops (4,373 kg⁻¹ha⁻¹yr⁻¹; 2,912 kg⁻¹ha⁻¹yr⁻¹; 134 g respectively). Mean percentage crude protein (CP) content of maize/lablab residues was higher (8.4 % CP) in intercrops than monocrops (4.0 % CP). Maize/lablab intercropping increased phosphorus and calcium content compared to maize monocrop. Cows that were offered residues from maize/lablab intercrop in addition to Napier grass as a basal diet during the dry season produced about 13 % more milk than cows on sole Napier grass (7.7 ± 0.02 litres cow⁻¹day⁻¹).

Major benefits identified by farmers during a participatory technology evaluation survey were: weeds were suppressed by lablab plants thereby reducing on labour and cost required to weed the fields; lablab plants conserved soil moisture; maize stover yield and quality, food security and household income improved.

Major lesson learnt from the study was that testing forage legume/food technologies with resource poor farmers is a very big challenge. It requires patience and institutional support. However, it improves adoption of the innovations.

This study revealed that lablab could be introduced as a component crop in an intercropping with maize to improve fodder and food availability.

Keywords: Fodder, food, forage legume, intensive smallholder dairy farms

Economic Viability of Crop Livestock Integration under Irrigated Conditions in Goiás State, Brazil

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On one hand, intensification of production systems is required to raise food production, on the other hand, rotation schemes become more and more relevant regarding the sustainability of the land use. In many countries crop livestock integration is being considered as one important strategy to improve productivity in a sustainable way. In the central region of Brazil there are many central pivot irrigation systems installed, which need to be used all over the year to be rentable. The aim of this study was to analyse the economic viability of crop livestock integration under irrigated conditions in Goiás State (Brazil). Four different levels of crop livestock integration were tested: **(1)** only cultivated pasture (only livestock across the year); **(2)** cultivated pasture during summer and irrigated common beans during winter (livestock from November to Mai); **(3)** maize and grass intercropping during summer and irrigated common beans during winter (livestock from November to Mai); and **(4)** maize during summer and irrigated common beans during winter (only crops; no livestock). The costs include depreciation of irrigation system and fences, inputs and operations (hours at commercial rates). The revenues include pasture renting and commercialising grains (maize and beans). The Benefit-Cost-Ratio (BCR) was used to compare the economic viability each level of crop livestock integration. Considering the four levels of crop livestock integration tested, only one was economically viable: using cultivated pasture during summer and common beans during winter, which obtained a BCR of 1.03. The evaluated levels of crop livestock integration, under the tested conditions, have limitations regarding their economic viability and need to be further researched.

Keywords: Agro pastoral system, economic feasibility, irrigation farming, pasture crop integration

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Urban and Peri-Urban Farming Systems and their Utilisation of the Natural Resources in the North Ethiopian Highlands

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The objective of this study was to characterise the urban and peri-urban dairy production systems and their level of integration with crop farming in the North western Ethiopian highlands. A field survey including 54 smallholder urban and peri-urban dairy farmers was conducted between July 2006 and March 2007 in the Bahir Dar milk shed areas. A structured questionnaire was developed to collect data in two different localities.

The results show that only 33.3 % of farmers undertake both crop and livestock farming. Mixed farming systems are mainly found in the peri-urban areas. Maize (*Zea mays*), tef (*Eragrostis tef*), finger millet (*Eleusine coracana*) and barley (*Hordeum vulgare*) are the most important crops cultivated which supply large amounts of crop residues as livestock feed.

An average of 14.2 livestock (73.3 % cattle, 22.1 % sheep, 1.1% goats and 3.4% equines) and 2.8 poultry were kept per household. Of the total cattle 68.2 % are crossbreeds (Zebu × Holstein Friesian), mainly found in the urban areas (57 %). For local cows, nearly all farmers use mixed-species open grazing (76.2 %) and rotational grazing (23.8 %); due to the high number of livestock grazing in a concentrated area, this practice probably contributes to substantial soil erosion because of overgrazing. On the other hand, 74 % of farmers use cut and carry system of feeding for crossbred cows. This shows that having crossbred cattle encourages farmers to use zero grazing system for feeding.

An average amount of 7.2 tons of dried manure per household is estimated to be annually produced. The manure is mainly used for fertilising crops and as fuel in the peri urban and urban areas, respectively.

It is concluded that small holder crop-livestock farmers could benefit from efficient utilisation of crop residues for animal feed and manure for crop production. Moreover, zero grazing could be one important option for efficient utilisation and conservation of the natural resources.

Keywords: Dairy farming, Ethiopia, livestock, peri-urban agriculture

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Investigations on Rice-Fish Culture in Myanmar

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Rice producing countries have an enormous potential to expand their aquaculture production by combining rice and fish culture. A field experiment of four month duration was carried at the Moe By Research Centre, Phe Kohn, Shan state, Myanmar, to optimise the stocking density of hybrid catfish (*Clarias batrachus* × *Clarias gariepinus*) in single and in polyculture with Nile tilapia (*Oreochromis niloticus*). The experiment was laid out in a randomised complete block design with 2 replicates per treatment and rice monoculture as control. The treatment groups included rice cultivation with 100 catfish (R100), 200 catfish (R200) or 100 catfish (catfish initial weight: 17.4 g) and 100 Nile tilapia (R100 100). The experimental plots (n=8) had a size of 400 square metres and were fertilised only once during the experimental period using mineral fertilisers. Supplementary feed for the fish was not provided.

The combination of 100 catfish hybrids with traditional rice culture (R100) resulted in the highest rice yield (4.1 t ha^{-1}) followed by rice monoculture (3.6 t ha^{-1}), whereas in the R200 and R100 100 group the rice harvest weights were significantly lower (2.5 t ha^{-1} and 2.1 t ha^{-1}). The mean fish weight (only catfish) was highest in R100 100 (106 g) while R100 and R200 showed average estimates of 102 and 82 g respectively. The net income generated from both rice and fish culture was highest in R100 (374 US Dollar ha^{-1}) and lowest in the R100 100 group (189 US Dollar ha^{-1}). In conclusion, rice-fish culture influences the net income in relation to the stocking density and species farmed. In the present study a stocking density of 100 catfish hybrids per plot was found optimal to maximise the net income from rice-fish culture.

Keywords: Catfish hybrids, net income, Nile tilapia, rice-fish culture

Dry Season Resource Use Efficiency of Cattle Farms in Olancho, Honduras and Implications for Forage Technology Adoption

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According to a representative sample, 74 % of smallholder livestock farmers (<20 cattle heads) in Olancho live below the poverty line (1\$/person/day). 65 % of farms earn less than 3 \$/person/day. Poverty is associated with sub optimal resource use in the dry season (3–6 months), when livestock holders feed purchased and farm supplements. Milk production in Olancho is highly dependent on commercial concentrates (62 % of the farms). Legumes for high quality protein feed and forage conservation are still rarely used. Resource use efficiency measured by the dry season net income per cow in milk divides farms in groups with the average monthly incomes: lowest- -15.63\$, low- 5.63\$, medium- 14.29\$ and top performers 32.49\$. These groups make up 32 %, 17 %, 30 % and 21 % in the sample.

Lowest and low performers showed a situation, which can be described as the ‘concentrate trap’: purchased feed supplements are used for herd maintenance only. Obstacles for the adoption of multi-purpose forage options are cash scarcity, lack of knowledge and the prevalence of dual-purpose cattle (milk and beef) with often low genetic potential for milk production. Low dry season milk production results in a decline of cash flow.

Medium performers use a higher variety of dry season feeding strategies employing more farm produced feed. Medium performers did not show dominance of a specific herd size, thus milk production can be profitable irrespective of herd size.

Although top performers use a wide range of dry season feeding strategies, expenses for purchased supplements are clearly higher than in the other groups. Capitalizing on better genetic potential of the cows, they use purchased inputs for production and not to fill the cows.

Possibilities for policy and development interventions in lowest and low performer’s systems should generate a continuous cash flow through year-round milk production, employing as much as possible forage based feed. Adoption of such technologies is most probable among top and medium performers, where some financial reserves are available and forages can increment profits. Once technology has sufficiently spread between top and medium performers, the profitability to utilise improved forages will likely convince low and lowest performers.

Keywords: Concentrate, forages, Honduras, milk production

Influence of Season and Management on Composition of Raw Camel (*Camelus dromedarius*) Milk in Khartoum State, Sudan

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The present study was designed to investigate the influence of seasons (winter and summer) on the chemical composition of raw camel (*Camelus dromedarius*) milk within two different management systems in two different locations around Khartoum State, Sudan. Camel milk samples (n = 112) were collected from Eastern Nile, where a semi-intensive management system is applied by some farmers (keeping some female camels with dairy cattle), and also from Western Omdurman, where traditional management is practised by transhumant farmers (abbala). The two locations were approximately 100 km apart. Major components of milk were determined and compared in both locations and for both seasons. Total solids, lactose and titratable acid were significantly higher ($p < 0.05$) in samples from Eastern Nile, while fat was significantly higher ($p < 0.01$) in samples from Western Omdurman. Differences in ash and protein content of the milk from the two different regions were not significant. Summer milk samples revealed significantly higher protein content in eastern Nile. All the other components of milk were found to be significantly higher in winter milk samples in both locations. The high water content in summer samples negatively affected the milk components compared to the samples collected in winter. In this study, the influence of season was found to be higher than that reported for management. It is concluded that the factor season through heat stress, feed availability, feed quality and water availability strongly affects camel milk composition, particularly the total solids content of the milk as well as the individual components.

Keywords: Camel, chemical composition, seasonal influence, Sudan

Evaluation of Lac Cultivation in two Southwestern Districts in Bangladesh

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Lac is the dermal secretion of the lac insect, *Kerria lacca* Kerr. deposit on a host plant (e.g. ber, fig). It is used to make expensive natural dye, burnish, coating material for ships, electronic purposes, raw material for lipstick, nail polish etc. Though it is a very perspective industry and host plants are available all over the country, especially in the southern districts of Bangladesh, lac cultivation is confined to some northern districts of Bangladesh. An experiment was conducted during July to October 2006 to find out the possibility of lac cultivation on ber plant in two southwestern districts of Bangladesh: Khulna and Satkhira compared to Chapainowabgonj, the main lac producing area.

The bark thickness, bark weight of ber plant as hose, ratio of harvested and inoculated lac sticks, harvested raw lac and harvested processed lac were measured and compared. Statistically non significant results were found meaning the similar performance of lac cultivation among the three regions. Numerically, the thickest bark of ber plant was found in Satkhira (0.100 cm) and the thinnest in Chapainowabgonj (0.095 cm). Mean bark weight of the ber plant was highest in Khulna (3.377 g) and the lowest was in Chapainowabgonj (3.254 g). Lac insects on ber plants at Khulna showed highest performance noticing 6.708 times harvested lac sticks against inoculated lac sticks and the lowest was found in Chapainowabgonj 6.360 times. A similar result was found regarding harvested raw lac. With regard to processed lac, the highest performance was found in Chapainowabgonj (96.360 g) and the lowest in Kolaroa (74.830 g). All these studies recommend that lac cultivation is possible at the southwestern part of Bangladesh.

Keywords: Lac sticks, raw lac, shellac, turi

Costs and Benefits of Traditional and Improved Dry Season Feeding Systems of Dairy Cattle for Smallholder Farmers in the Peruvian Andes

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During the dry season, lack of precipitation reduces growth and quality of non-irrigated forage resources in the central Peruvian Andes, resulting in a reduction of milk yield and milk quality. In four Andean communities, 56 farmers were interviewed every three months over a period of one year. Information linked to agriculture and livestock farming such as activities, inputs (labour, means of production, capital) and outputs (milk, cheese, meat, animals, crops) were recorded using a closed-ended questionnaire. Furthermore, samples of supplements for dairy cattle were analysed for their contents of crude protein (CP), fibre (NDF) and net energy for lactation (NEL). The most common supplements during the dry season were a home-made concentrate (with flour and bran of oat and barley as main components), oat hay and straw (from barley or oat), which contained on average, per kg of dry matter (DM) 119, 57 and 40 g of CP, 324, 572 and 731 g of NDF, and 7.7, 5.5 and 4.1 MJ of NEL, respectively. The communities were divided into two groups with high (CH) and low (CL) level of dependence on income from milk production. On average, each household owned 4 and 0.5 dairy cows producing 550 and 750 kg milk/cow/year, in CH and CL groups, respectively. Values derived from the survey were introduced into a simulation model which optimised household income through linear programming. The model was used to compare the traditional dry season feeding system, consisting of supplementation of dairy cows with hay and straw from oat and barley, cut ryegrass (*Lolium* sp.) and small amounts of cereal bran with an improved system introducing the hay of improved forage varieties (*Avena sativa* var. Mantaro 15, *Hordeum vulgare* var. UNA 80, *Triticosecale Wittmack*). The best land use solution proposed by the model was a combination of fertilised *Lolium* sp., fertilised *Hordeum vulgare* var. UNA 80 and native pasture. Farm income from livestock would rise with this new system from 199 to 211 US\$/ha/year for CH and from 32 to 277 US\$/ha/year for CL, demonstrating clear improvements achieved by small changes in land use and animal feeding practices.

Keywords: Dry season feeding, household model, milk production, Peru

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From Subsistence to Market Oriented Livestock Smallholders Development in Nicaragua and Honduras

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Many families in large dry areas in lowland and mountain zones in Nicaragua and Honduras are at subsistence level and live under unstable conditions. Traditional farming practices and poor efficiency in the use of livestock capital hinder the improvement of the living standard of smallholders. Off-farm sectors may complement the opportunities for rural development and income generation.

The overall objective of the research is to analyse livestock farming systems and evaluate their potential for future development toward higher living standards through the transition from subsistence to market orientation. To achieve this there is a need to understand the subsistence and market oriented livestock farming systems and their determinants for development in dry areas of different countries. It is also necessary to explain the development and interrelationships within the farming systems by focusing on resources, technologies, markets relations and those external factors that enhance the transition from subsistence to market orientation. Furthermore, one should explain and analyse the potential of off-farm activities and income as a complement to farming development. The whole analysis will address to the definition of future strategies of development and their potential impacts on the improvement of living standards by using dynamic risk models.

The research will bring out a clear understanding of the subsistence and market oriented livestock farming systems and the determinants for a transition from subsistence to market farming orientation in different administrative and ecological environments. These results will facilitate the designing of more effective policies and strategies for rural development in dry zones of Nicaragua and Honduras based on the understanding of farm and family as one system. Additionally, it will highlight the need of more research on the different faming systems in other zones of the countries.

Keywords: Dry areas, livestock, lowland, farming systems, mountain farming systems, smallholders

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Implications of Climate Change Clean Development Mechanisms on Livestock Agricultural Modernisation in Africa: Case Studies in Uganda

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Clean Development Mechanism (CDM) is a Flexible Mechanism designed by the United Nations Framework Convention for Climate Change to encourage cooperation of the developed nations in promoting sustainable socioeconomic development in less developed countries while mitigating emission of Green House Gases. CDM benefit to the animal sector is to attract support from developed countries, including private sector, in promoting improved methods of milk and meat production, and provision of animal draught power, while reducing methane emission. A prerequisite for such investment is establishment of a baseline projection under non-improvement scenario, which serves as an auditing tool for such interventions. Therefore a baseline survey was conducted in 14 districts of Uganda, respecting various cattle production and management scenarios. The specific objectives were to understand the conditions, knowledge base, motives and cattle base of the cattle keepers on various parts of the country; and to develop production targets for meat, milk and draught power for the next 30 years; and to estimate the amount of methane associated with developments of using the current knowledge and cattle resource base. Also, the implications of this environmental concern on the directions livestock agriculture to meet the cattle meat, milk and traction demand was assessed. Results indicated that to meet the demand for meat and milk for a growing population over the next 30 years, the country would require a cattle population of 10.4, 13.9, 18.7, 27.4 and 40.2 million heads of cattle during the target years of 2010, 2015, 2020, 2025, and 2030 respectively. This will be associated with 0.317, 0.571, 1.03, 1.52, and 2.25 million tons of methane production in the respective years. At the current growth rate of cattle population, Uganda will not have enough animals to meet demand for milk and meat. The Ankole, Zebu, Nganda and improved cattle breeds will produce 899.8, 803.6, 798.3, 82.1 g of methane kg^{-1} of milk, suggesting a strong reason for adoption of improved breeds to increase productivity while reducing methane gas emission. The genetic base should be however fully exploited with better environmental analysis.

Keywords: Livestock agriculture modernisation, clean development mechanism, climate change, global warming, greenhouse gases, methane

Economic Efficiency of Feedlot Cattle Farms in Thailand

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Cattle raising has been identified as 1 of 14 main products in Thai agriculture. Although, the growth rates of cattle farms and heads have been recognised, beef production in Thailand has not been sufficient for domestic consumption. Therefore, production improvement is the main concern of this sector.

The main purpose of this study is to measure and investigate factors affecting economic inefficiency of feedlot cattle farms in Thailand. Previous studies have investigated technical efficiency and its components at both the farm and aggregate levels in Thai agriculture, yet no study has measured and explained economic inefficiency of feedlot cattle production at the farm level in Thai agriculture. Valuable information on the economic efficiency is necessary for policy makers to enable them to choose the appropriate direction of development planning to sustain food security, improve resource allocation and, thus, reduce poverty in Thailand

To fulfil the above objective, the data envelopment analysis (DEA) approach and farm-level cross-sectional survey data of cattle farms in two provinces of the Southern Region in Thailand are used. In the second stage, in order to examine the effect of farm-specific socio-economic and management factors on farm efficiency, a Tobit regression is estimated where the level of inefficiency from DEA is expressed as a function of these factors. Through this, the likelihood of changes in economic inefficiency are explained by the above variables.

These empirical results suggest four important findings. First, the efficiency scores of some farms were considerably low. This implies that there is significant scope to increase efficiency levels in Thai cattle farms. Second, the results indicate that allocative inefficiency makes a greater contribution to economic inefficiency among farms. Third, the results also indicate that the Thai cattle farms over-utilised fertiliser, labour, capital and land inputs, while they under-utilised other inputs. Finally, there is a confirmation that farm size has influenced the allocative inefficiency of cattle farms in Thailand.

Keywords: Cattle farms, DEA, economic efficiency, food production, Thailand, Tobit regression

Potentials and Constraints of Little Bag Silage in Honduras

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Silage produced in little plastic bags (LBS) is seen as a promising forage conservation technology for small-scale farmers. Within a participatory research project carried out by CIAT and partners in Honduras, innovation with LBS was stimulated during farmer trainings and field days.

A suitable prototype bag system was developed in collaboration with farmers: The use of a removable mould (i.e. plastic barrel) during elaboration of bag silages of higher capacities (> 30 kg) eases compaction and protects the plastic material from stretching and tearing. High quality bag silages were produced from, e.g. maize, sorghum, *Vigna unguiculata*, *Cratylia argentea* and *Brachiaria brizantha* cv. Toledo. As experienced by farmers, the main potential of LBS is because of low investment costs, easy handling, low requirements for labour and technical equipment, rapid filling, and the use of small amounts of high-quality forages. In addition, LBS proved to be a useful tool to demonstrate and teach basic principles of silage technology.

However, up to date, adoption of LBS has been low, especially by smallholders. Restrictions to success include availability of suitable and cheap plastic bags, high silage losses due to perforation of plastic bags caused by inappropriate handling, coarse stems, and animals (i.e. mice), and lack of adequate storage facilities in many smallholder farms. Moreover, silage adoption by smallholders is often constrained by a) access to a chopper (as hand-chopping is cumbersome, time- and/or labour-intensive), b) tradition, c) use of non-productive livestock breeds, and d) availability of alternative low cost feeds, i.e. maize residues, natural herbage, improved pasture grasses and sorghum straw. Results show that silage novices rather adopted other silo types with higher capacity (i.e. heap and earth silos), either immediately or after having tried LBS.

Despite of low adoption, LBS technology proved useful as a) a demonstration, experimentation and learning tool that can be used as adaptable prototype in farmer trainings and field days and, b) to get small-scale silage novices started with the technology at a low risk.

Keywords: Adoption, forage conservation, innovation, LBS, silage

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Gender Role, Present Situation, Constraints and Opportunities: Is it a Challenge for Livestock Research and Development in Nepal?

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Gender is the term used to refer to the socially constructed relations between women and men in a particular society. There is a strong relationship between gender and agriculture in developing countries. According to the UN report (2000) on the status of women, women are twice as likely as men to be involved in agriculture-related activities. Moreover, two-thirds of the world's 876 million illiterates are women, most of whom live in rural areas of developing countries. National averages of female workers in the agricultural labour force vary. But globally women have a principal role in agribusiness, food processing, and consumer related activities.

As far as Nepal, a Himalayan country, is concerned, livestock plays a significant role to the national economy. Buffalo is the most preferred ruminant that contributes about 70 and 65 % share to the national milk and meat production respectively. A study carried out on gender aspect revealed that women perform more than two-thirds of the total agricultural works but their participation in capacity buildings viz: group formation and mobilisation, exposure to new technology, training, etc. is only about 40 %. Specifically, women participation in group formed for goat keeping is the highest (57.2 %) where as it is lowest in the case of buffalo farming group (18.4 %). It clearly shows that women have only got the opportunity towards the small ruminants but they are neglected to the most important enterprises like buffalo and cattle.

Experience has shown that when women in developing countries, like Nepal, are empowered, the benefits are felt in entire families and communities. Constraints such as lack of capital and access to institutional credit, social and cultural norms, education and poverty, lack of technical skills and access to extension services affect women more than men and limit women's participation and efficiency in livestock production. However, positive trend of women education, government policy towards capacity building, women advocacy and developing partnership show the opportunity for the women and ultimately for the livestock research and development in Nepal.

Keywords: Capacity building, gender, livestock, research and development

Yield Development and Quality Changes of High Yielding Grasses During the Rainy Season in the “Natural Reserve Area Chacocente” on the Nicaraguan Pacific Coast

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The “Natural Reserve Area Chacocente” on Nicaragua’s pacific coast needs to find alternatives in livestock production to increase rural incomes and - at the same time - protect natural resources. This study examines the potential of sugarcane (*Saccharum officinarum* L.) and two types of elephant grass - Taiwan (*Pennisetum purpureum* Schumach. cv. Taiwan A-144) and King Grass (*Pennisetum purpureum* Schumach. × *Pennisetum americanum* L.) - for fodder production. The study describes the development of yield and nutritive value during maturation of grasses as baseline knowledge to develop possible preservation strategies (hay, silage) for excess fodder grown during the rainy season. A field experiment with the three grasses was established on a “Eutric Cambisol” under semiarid conditions (900 mm annual precipitation) in May 2006. The randomised block design comprised three factors: grass genotype, N fertiliser (N₁: 0 kg ha⁻¹; N₂: 100 kg ha⁻¹) and sampling date (total of 10 dates). Samples were collected from mid June to mid September in ten day intervals. At each sampling, dry matter, plant height, leaf/steam-ratio, dry matter content and tiller density was measured. Contents of crude protein and metabolisable energy were determined using NIRS calibrations developed from the material of this study. Effects of genotype, N fertilisation and cutting date were analysed using multivariate statistics. The dynamics of yield and quality development over time was described using the growth function of Boguslawski. The highest yields were measured in King Grass. At the last sampling (114 days after planting), dry matter yields of 27.7 t ha⁻¹ for King Grass, 22.1 t ha⁻¹ for Taiwan and 10.9 t ha⁻¹ for sugarcane were measured. The crude protein content ranged from 22.0 % (Taiwan, fertilised, 47 days) to 3.5 % (King Grass, unfertilised, 114 days), while metabolisable energy had values from 9.7 MJ kg⁻¹ DM⁻¹ (Taiwan, unfertilised, 37 days) to 6.0 MJ kg⁻¹ DM⁻¹ (Taiwan, fertilised, 114 days). Sugarcane seems to be less suitable because of a late growth whereas elephant grass may require the addition of protein-rich legumes during preservation. However, such investments seem to be profitable only for dairy producers and only as part of a package combining fodder production, animal health care, milk marketing, and training.

Keywords: Dry season feeding, livestock production, tropical grasses

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Livestock genetic resources and production systems

Oral Presentations	67
JEANNETTE VAN DE STEEG, MANITRA RAKOTOARISOA, AN NOTENBAERT, MARIO HERRERO: Global Changes in Livestock-Based Systems, Does it Matter for the Poor?	67
SIMON RIEDEL, CLEMENS WOLLNY, WORKNEH AYALEW, TEMES-GEN AYANA: Participatory Assessment of Incidence and Perception of Bovine Trypanosomosis by Cattle Farmers in Dano, Western Ethiopia	68
HARUN WARUI, BRIGITTE KAUFMANN, CHRISTIAN HÜLSEBUSCH, HANS-PETER PIEPHO, ANNE VALLE ZÁRATE: Reproductive Performance of Local Goats in Extensive Production Systems of Arid Northern Kenya: Implications on Reproduction Management of Small Ruminants	69
ULRIKE JANSSEN-TAPKEN, LUC L.G. JANSSE, HAJA N. KADARMIDEEN: Population Parameters for Trypanotolerance Traits in an N'Dama × Boran Crossbreeding Population	70
Posters	71
SANCHAI JATURASITHA, SUPASID BOONNOUL, NUCHA SIMASATIKUL, AMNUAY LEAWTHARAKUL, MICHAEL WICKE, SEBASTIAN CHAKEREDZA, UDO TER MEULEN: Fatty Acid and Amino Acid Profiles of Breast and Thigh Muscle of Bresse and Black-Boned (Cheefah and Fahluang) Chickens Raised in North Thailand	71
SANCHAI JATURASITHA, RAKKEART NORKEAW, THERDCHAI VEARASILP, THUMRONGSAKD PHONBUMRUNG, KHEMSAWAT CHEERAWAT, MICHAEL WICKE: Effect of Type of Grazing on Meat Quality of Thai Native Cattle	72
GUSTAVO GANDINI, KERSTIN ZANDER, ADAM DRUCKER: Combating Extinction through the Economic Assessment and Capture of the Cultural Values of the Italian Valdostana Castana Cattle Breed	73

- KESINEE GATPHAYAK, RANGSUN CHAROENSOOK, SUMALEE TAESOONGNERN, SUPALERK LAIPRAWAT, NUCHA SIMASATIKUL, T. APICHARTSRUNGKON, RATCHANEewan KUMPHAKARM, BERTRAM BREINIG, CHRISTOPH KNORR:
Identification of Porcine *Hernia inguinalis/scrotalis* Using Single Nucleotide Polymorphism in INSL3 and Bax Genes 74
- NUCHA SIMASATIKUL, NATTAPHON CHONGKASIKIT, NAKARIN PRIPWAI, THERDCHAI VEARASILP, UDO TER MEULEN:
Influence of Production System on Carcass Composition of Native and White Lamphun Cattle in the Northern Provinces of Thailand 75
- ATHANASE YOUAN BI, DAO DAOU DA, LEHMANN BERNARD, DUMONDEL MICHEL:
Bovine Stock Breeding Systems Influence on the Farms' Technical Efficiency in Côte d'Ivoire 76
- THI MAI HUONG PHAM, MARCUS MERGENTHALER, BRIGITTE KAUFMANN, ANNE VALLE ZÁRATE:
Speciality Pork from Indigenous Pig Breeds to Improve Rural Incomes 77
-

Global Changes in Livestock-Based Systems, Does it Matter for the Poor?

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The growing markets and rapid growth in demand for livestock products has been termed the livestock revolution. It is driven by rising income, urbanisation, and changing consumer preferences particularly among a growing middle class. Expanding domestic and export markets for livestock and rapidly growing demands create growth opportunities for livestock producers in the developing world. Globally there is a geographic shift in livestock production from the developed to developing countries. However, recent trends in the developing world like the lengthening of livestock food chains, vertically integrated livestock food chains, and increasing market concentration in the sector can marginalise smallholder producers and other poor people who depend on livestock for their livelihoods. The livestock revolution therefore has so far seemed to bypass the livestock sector in the least developed countries where the bulk of the poor live. Moreover, the increased production of livestock is also expected to come from the same or declining resource base. In many cases, this may lead to degradation of land, water, and animal genetic resources in both intensive and extensive livestock systems.

This study investigates the distribution of livestock systems (intensive versus extensive) over time and across countries and relate this to economic variables (such as livestock contribution to agriculture GDP, poverty index, market access), production systems variables (such as farming systems, technology, productivity) and environmental variables (such as water, land use and degradation). By doing so this research tries to enhance the understanding of relevant characteristics and trends in livestock systems at a global level. Additionally this study will conduct regional analysis for Africa, to analyse the relation between livestock systems, livestock productivity and poverty index levels in more detail. By doing so we aim to answer the question: Global changes in livestock-based systems, does it matter for the poor?

Keywords: Farming system, global changes, livestock production, poverty, trends

Participatory Assessment of Incidence and Perception of Bovine Trypanosomosis by Cattle Farmers in Dano, Western Ethiopia

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Indigenous cattle contribute greatly to food security and livelihoods of farmers in marginal environments. In Dano, a small village in western Ethiopia, inhabited by small-scale cattle keepers, strengthening farmers' skills to manage their animals will significantly improve their livelihoods and reduce poverty. In a PRA survey, cattle keepers in Dano mentioned trypanosomosis as major problem in animal husbandry. This study analyses trypanosomosis prevalence and indigenous practices to manage trypanosomosis and other relevant diseases. Sixty-three farmers were interviewed about common cattle diseases, their prevalence and farmers' management practices to cope with those diseases, by applying standardised questionnaires. Two hundred eighty-four cattle were blood-tested for trypanosomosis detection, using buffy coat technique, and eighty-eight farmers were chosen to provide information about their identification of apparently sick cattle in a participatory practical unit. Overall trypanosomosis prevalence among the cattle herds was found to be 14.5%. Farmers identified infected cattle by hair loss, diarrhea and weakness; they believed transmission occurred mainly through physical contact with infected animals (49%) and by unknown reason (33%). Six percent of farmers knew about the linkage between tsetse flies and trypanosomosis. Modern and local drugs were used to treat trypanosomosis infected cattle, the strategies for local treatment followed methods like branding and the usage of herbs. From the eighty-eight apparently sick cattle which were blood-tested for trypanosomosis infection, 29.5% were trypanosomosis positive and 75% had PCV below 26. The farmers seemed to lack basic knowledge about disease management but showed strong interest in participating in health improvement actions; - 92% - of them were willing to contribute labour and money according to community agreements for trypanosomosis eradication efforts. Potential future research and development approaches which aim to control cattle diseases, especially trypanosomosis, are presented in the study, focusing on approaches which fit into the whole background of incentives to farmers, their behaviour, and understanding of animal health issues. The aim of those efforts is to sustainably improve Dano farmers' cattle keeping skills, leading to a better utilisation of their local animal genetic resources.

Keywords: Community-based management, cattle, disease management, Ethiopia, indigenous knowledge, tsetse fly

Reproductive Performance of Local Goats in Extensive Production Systems of Arid Northern Kenya: Implications on Reproduction Management of Small Ruminants

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Goats in the arid and semi arid lowlands of northern Kenya are kept in a harsh and resource poor environment. The goats' reproductive performance is an indicator of their adaptation to the adverse conditions. A six months field study was carried out to assess reproductive performance of Gabra and Rendille goat populations in Marsabit district of northern Kenya. Reproduction data of 444 Gabra and 432 Rendille female goats (does) with 1267 and 1602 parturitions during period 1997 to 2006, was gathered using progeny history survey technique. Reproduction parameters were calculated both at the doe level (age at first birth and average kidding interval) and population level (abortion, mortality and annual reproductive rates). Main and interaction effects of goat population, goat adaptation types and number of parturitions, with the number of abortions as the covariate, were assessed in an ANCOVA model. A saturated loglinear model was fitted for the number of first births for does at different combinations of age by goat population, type of year of birth and goat adaptation type. Logit models were used in the analysis of abortions and occurrence of kid mortality by goat population, goat adaptation type, doe's parity and sex of kid (only for mortality data). Rendille goats had better reproductive performance than the Gabra goats. Most important was the higher mortality rates of 25% for kids at the age of 3 to 8 months in Gabra goats than in Rendille goat kids (13%). Nevertheless the reproduction parameter values in both goat populations were similar to those observed in other pastoral systems. Reproduction management by the Gabra livestock keepers of striving for higher kidding rate during the long dry season of normal years could be contributing to the high kid mortality rate. Management measures to reduce reproduction wastage are recommended, especially in years that coincide with post drought periods in order to facilitate fast building of flocks. Such measures will also impact positively on the reproduction performance of sheep since both species are managed together in the pastoral systems of northern Kenya.

Keywords: Arid areas, goats, livestock keepers' knowledge, local breeds, reproductive performance, resource poor systems

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Population Parameters for Trypanotolerance Traits in an N'Dama × Boran Crossbreeding Population

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In 1983 the crossbreeding between trypanotolerant N'Dama (*Bos taurus*) and trypanosusceptible Boran (*Bos indicus*) cattle was initiated at the International Livestock Institute (ILRI) in Kenya to construct a population with a pedigree structure fit to detect quantitative trait loci (QTL) for trypanotolerance. QTL contributing to the three major tolerance indicators anaemia, body weight (BW) and parasitaemia control were found. To evaluate the use of this information in a breeding programme with special focus on trypanotolerance, the estimation of population parameters is required.

Phenotypic and genetic variances and correlations as well as heritabilities have been estimated for the sixteen defined traits used to detect QTL in 176 F2 offspring. Heritability estimates range from 0.11 to 0.45 with sufficient variances in the phenotype suggesting successful breeding opportunities. The estimates confirm the genetic control of the three major tolerance indicators. The genetic correlations between the traits give further evidence to the suspected independence of the mechanisms for the control of parasitaemia in comparison to red packed cell volume (PCV) and BW. While PCV-traits and BW traits are rather strongly correlated, parasite count and detection rate appear to be independent from the others. BW at the age of 12 months before challenge (BWI) is favourably though little correlated with any of the PCV traits, indicating that good nutrition would have a small positive effect on the ability of an animal to fight the infection. The starting value for PCV is slightly correlated with a less severe reduction in PCV and a better regeneration from the lowest PCV reached during infection. The very limited correlation between both prechallenge traits (initial PCV and BWI) clearly demonstrate that selection for trypanotolerance depends on traits that require data from infected animals unless marker information for QTL could be used instead.

With the estimated population parameters, it is now possible to evaluate genetic merit for trypanotolerance traits in a simulated breeding scheme and from there develop a breeding programme for cattle with a special focus on trypanotolerance to address locations where alternative control strategies would be difficult to implement or maintain due to the lack of resources and infrastructure.

Keywords: Boran, heritability, N'Dama, population parameters, trypanotolerance

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Fatty Acid and Amino Acid Profiles of Breast and Thigh Muscle of Bresse and Black-Boned (Cheefah and Fahuang) Chickens Raised in North Thailand

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Consumers in Thailand have a high preference for Black-boned chicken meat and are willing to pay a premium price on the market. This “good” taste is attributed to the high glutamic acid content in the meat. The current study was set up to compare the fatty acid and amino acid profiles in Bresse (Bre) and Black-bone (Cheefah; Che and Fahuang; Fah) chickens. Eighty chicks (40 males and 40 females) for each strain were selected for the study. Within strain and sex the chicks were randomly divided into eight groups of five chicks each and used in a completely randomised design with a 3 × 2 factorial combination of treatments. The chicks were fed a common diet and slaughtered at 16 weeks of age. Breast (*Pectoralis major*) and thigh (*Biceps femoris*) muscles were collected for the assessment of fatty acid and amino acid composition. The ratios of unsaturated to saturated fatty acid (UFA:SFA) and polyenic fatty acid to saturated fatty acid (P:S) in breast and thigh muscles of Bre were significantly ($p < 0.01$) higher than Che and Fah chickens. Within strain, the UFA:SFA and P:S ratios were significantly ($p < 0.01$) higher in males than females. The breast muscle of Bre chickens tended to have lower glutamic acid content compared to Che and Fah. The thigh muscle glutamic acid content of Fah was significantly ($p < 0.001$) higher to Bre and Che chickens. There were no significant ($p > 0.05$) interactions. Therefore, although the Bre chickens had a better fatty acid composition, the meat taste could be negatively affected by the lower glutamic acid content relative to that of the Black-boned chickens (Fah and Che). From this perspective, the black-boned chickens (Fah and Che) have potential to meet the consumers’ taste preference.

Keywords: Amino acid, black-boned chicken, fatty acid

Effect of Type of Grazing on Meat Quality of Thai Native Cattle

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Native cattle of the family of *Bos indicus* are in Thailand kept as draught animals mainly in rice fields. After field discharge some are sold in the market and later slaughtered. The beef quality is poor because the animals are slaughtered at old age. The objective of this investigation was to study the beef quality of 3 years old native cattle grazed on different types of pasture. Twelve calves were reared with their dams until one year of age after which they were randomly divided into two groups and grazed for the next two years. One group of calves was grazed on a pasture of pure Guinea grass (*Panicum maxima*) whereas the second group was kept on Guinea grass mixed with the legume *Stylosanthes guianensis*. The three years old calves were slaughtered and their *Longissimus dorsi* collected in order to study the meat quality. Meat quality in terms of pH- and conductivity value was not significantly different between the two groups ($P > 0.05$). The lightness value (L) of meat of cattle grazed on Guinea grass was darker than that of cattle grazed on mixed pasture ($P < 0.01$). The sensory evaluation in terms of tenderness, taste and acceptability found no significant difference between the groups ($P > 0.05$) whereas the juiciness of the beef from the group grazed on Guinea grass pasture was higher than that of the group grazed on mixed pasture ($P < 0.05$). The chemical composition, water holding capacity, shear force value as well as collagen content of beef were not statistically different ($P > 0.05$) between the two groups whereas the cholesterol and triglyceride content of beef from animals grazed on pure Guinea grass was lower than from those grazed on mixed pasture ($P < 0.05$). In conclusion, Thai native cattle grazed on pure Guinea grass pasture had a more favourable beef quality compared to cattle grazed on Guinea grass mixed with legume.

Keywords: Beef quality, grazing type, Thai native cattle

Combating Extinction through the Economic Assessment and Capture of the Cultural Values of the Italian Valdostana Castana Cattle Breed

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The number of local livestock breeds and the important animal genetic resources (AnGR) that they represent is declining, both at a global level and within European countries. In Europe, the process of extinction is mainly associated with their lower financial profitability relative to other breeds and alternative economic activities.

Economic valuation of AnGR provides an important tool with which to justify conservation priorities. The development of appropriate valuation methodologies has advanced significantly over recent years. Nevertheless, cultural values are often neglected in the calculation of the total economic value (TEV) of livestock breeds, leading to their sub-optimal conservation and use. One reason for this is that assessing cultural aspects and other non-market values of livestock is challenging due to their common resource character. AnGR and in particular their cultural value may be considered as a quasi-public good, responsible for various positive global externalities and generating benefits of a non-excludable nature.

This paper explores a component of the non-market value of the Italian Valdostana Castana cattle breed through the use of a survey-based contingent valuation method (CVM). Particular focus is placed on the cultural value of the Valdostana Castana as this breed still plays a central part in the socio-cultural and agricultural activities of the rural population in the Aosta valley. For the purposes of this study, cultural values are understood to be those associated with cultural events involving the Valdostana Castana (such as the “Battle of the Queens”). The CVM involves assessing local residents’ and tourists’ willingness to pay for the specific services that are directly or indirectly obtained from the maintenance of this breed by local farmers. Based on the results of this study, policy measures that could facilitate the capture of such values and their being channelled towards the conservation and sustainable use of the Valdostana Castana cattle breed are presented.

Keywords: Animal genetic resources, contingent valuation, cultural values, Italy, Valdostana Castana cattle breed

Identification of Porcine *Hernia inguinalis/scrotalis* Using Single Nucleotide Polymorphism in INSL3 and Bax Genes

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Scrotal hernia is a congenital defect of great concern to pig producers that leads to economic loss and poor animal welfare. Several candidate genes have been proposed to be causative for the disorder. This study focused on the analysis of single nucleotide polymorphisms in the genes encoding the Leydig insulin-like hormone (INSL3) and the BCL2-associated X protein (BAX). INSL3 has recently been mapped to SSC2q12-q13 and BAX to SSC6q21. In total, 250 bp in INSL3 (promotor region) and 416 bp in BAX (Intron1) were comparatively sequenced using affected and un-affected commercial pigs as well as autochthonous Thai pigs. PCR-RFLP was used to screen SNP-G-224A (INSL3) and C119T (BAX). A total of 212 commercial pigs (179 unaffected (u) and 33 herniated (h) pigs) were used for INSL3 genotyping. Allele frequency estimations revealed no significant differences between the two phenotypes at this loci (Gu = 0.97; Au = 0.03; Gh = 0.91; Ah = 0.09) indicating that this mutation cannot be used to identify the disease. Interestingly, the allele frequency for G in Thai native pigs (n=7) was 0.07. It appears that the breed differences exist in the INSL3 gene. Screening of BAX was done in 151 commercial pigs (125 unaffected and 26 herniated pigs) showing significant differences in allele frequencies between unaffected and herniated pigs (C:T = 0.62:0.38 and 0.83:0.17) ($p < 0.01$). Allele C in Thai native pigs (n=7) was 1.00. Currently, further mutations in the regulatory and coding regions of BAX are identified to assess their possible role in this congenital disorder.

Keywords: BAX genes, INSL3, porcine *Hernia inguinalis*

Influence of Production System on Carcass Composition of Native and White Lamphun Cattle in the Northern Provinces of Thailand

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In the northern provinces of Thailand there are a number of small traditional cattle farms producing beef. The objectives of this study were to evaluate the influence of cattle production system on carcass composition of native and white lamphun cattle in these areas. Most of the farms practice extensive production system. The cattle are let out to graze in the fields during the day and are kept at the farms at night. Some cattle have access to grazing areas in the forests and in the hills. At 1-2 years old, native and White Lamphun cattle averaged 154.62 ± 37.35 kg live weight while the carcass weight was 80.87 ± 19.34 kg giving a dressing out percentage of 52.37 ± 3.08 %. There were no differences ($p > 0.05$) in live weight, carcass weight and dressing out percentage between the native and white lamphun cattle. However, the relative percentage weight of the head, liver - gall bladder and kidney of native cattle (4.72 ± 0.57 , 1.30 ± 0.14 and 0.27 ± 0.04 % respectively) were higher ($p < 0.05$) than of the white Lamphun cattle (3.61 ± 0.11 , 1.49 ± 0.11 and 0.21 ± 0.03 % respectively). Relative percentage of chuck and shank of native cattle in Lampang province (17.80 ± 3.13 and 13.31 ± 2.91 % respectively) were higher ($P < 0.05$) than of native cattle in Lamphun province (12.34 ± 5.15 and 11.49 ± 2.58 % respectively). The other portions showed no significant ($p > 0.05$) differences. Tenderloin percentage of cattle in summer were significantly ($p < 0.05$) higher than cattle in rainy season (9.87 ± 2.09 and 4.41 ± 0.86 , respectively) but primal round, untrimmed neck roll and brisket of cattle in summer season (21.97 ± 4.32 , 2.57 ± 0.59 and 0.02 ± 0.01 % respectively) were significantly ($p < 0.05$) lower than of cattle in the rainy season (25.35 ± 1.44 , 5.46 ± 1.88 and 2.18 ± 0.60 % respectively). The results show that white lamphun cattle yield more meat than native cattle and that better quality meat is obtained from cattle slaughtered in the rainy season.

Keywords: Carcass composition, dressing percentage, native cattle, white Lamphun cattle, Thailand

Bovine Stock Breeding Systems Influence on the Farms' Technical Efficiency in Côte d'Ivoire

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In 2001, Ivory Coast counted 1 440 000 bovines, and this production is not sufficient to cover national consumption. Its performance does not make it possible to face external competition. In order to determine and to compare the various systems of bovine stock breeding in terms of efficacy, a study was carried out in the north (Korhogo) and the centre (Toumodi). Ninety five (95) bovine stock breeders were implied.

A classification of stock breeding systems was made according to management criteria, livestock size and individual characteristics' of the stockbreeders. Then, we used the data envelopment analysis (DEA) method to determine their efficiency. The Tobit regression applicated to the "slacks" resulting from the DEA calculation made it possible to evaluate the stock breeding systems influence on the inputs. A final DEA was applied to the adjusted inputs of the influences of the breeding systems.

We identified three stock breedings classes:

- nomads class, composed of stockbreeders coming from Burkina, Mali and Niger, was excluded from the data during efficiency calculations,
- community stock breedings with few animals and without care. This class seems to be a new system and contains few stockbreeders,
- individual stock breedings being usual and individually practised extensively.

The managerial efficiency evaluation led us to the determination of the global technical efficiency (69.77 %) and pure technical efficiency (18.22 %). That permits to know the rate of the inefficiency of scale (16.74 %). Community system in Korhogo represents the most favourable environment and the individual system characterises the most unfavourable environment.

We can recommande all initiatives in favour of the popularisation of the community stock breeding system.

Keywords: Bovine, Ivory Coast, tobit regression, DEA

Speciality Pork from Indigenous Pig Breeds to Improve Rural Incomes

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Profitable livestock husbandry of indigenous pig breeds can play an important role in conserving animal genetic diversity. At the same time it has the potential to increase and diversify household income of poor farmers in remote areas if market access to speciality markets can be provided. In order to analyse the importance of marketing arrangement among actors involved in marketing of pigs, we use data from a supply chain survey in the mountainous region of northern Viet Nam. In addition a sample of 70 households keeping the improved Mong Cai or indigenous Ban as sow breeds in three villages in the same region is used to analyze economic impacts of indigenous pig breeds and marketing arrangements at the household level. For this purpose we compare the production economics of improved and indigenous pig breeds and look at the different marketing arrangements.

First results show that markets are characterized by locality and short geographic distance among actors, irrespective of breed. Because production is mainly resource-driven, farmers only sell small numbers of indigenous pigs to the market. Due to an increase in demand for this speciality pork, indigenous pig producing households seem not depend so much on preferred traders. Net profit margin per unit of pork increases from improved pigs to crossbred offspring of indigenous pigs and to indigenous pigs.

We also compared production economics at the household level. Income from pig production increases with closer proximity to markets. We could also find that within the same production condition households with trading relations will get higher income than those without trading relations. The breed effect for indigenous pig breeds is positive.

Our results show, how through the development of speciality markets, indigenous pig breeds can be conserved *in situ*, while at the same time making a contribution to increase rural incomes. Once marketing arrangements are systematically established, benefits for farmers could be further increased. A challenge exists to better link farmers in remote areas to emerging speciality markets.

Keywords: Indigenous breed, marketing arrangements, pigs, Viet Nam

Technological innovations in agriculture

Oral Presentations	81
URBANUS N. MUTWIWA, JOHANNES MAX, HANS JURGEN TANTAU: Effect of Greenhouse Cooling Method on the Growth and Yield of Tomato in the Tropics	81
MARTIN KRATZEISEN, ELMAR STUMPF, JOACHIM MUELLER: Development of a Plant Oil Pressure Stove	82
ANJUM MUNIR, OLIVER HENSEL: Development of a Solar Distillation System for Essential Oils Extraction from Herbs	83
JÖRN GERMER, MICHAEL YONGHA BOH, JOACHIM SAUERBORN: Co-Composting as a Disposal Solution for Faecal Sludge from Innovative Pit Latrines	84
Posters	85
FOLARIN ALONGE, OLAOLUWA ONIYA: An Indirect Passive Solar Dryer for Crop Drying	85
FRANZ ROMAN, MARCUS NAGLE, HERMANN LEIS, SERM JANJAI, BUSARAKORN MAHAYOTHEE, METHINEE HAEWSUNGCHAROEN, JOACHIM MUELLER: Investigation of Solar Roof Collectors for Preheating of Air at Drying Facilities in Northern Thailand	86
JUAN CARLOS GONZALEZ AZCARRAGA, MARCUS NAGLE, SARAWUT PHUPAICHITKUN, BUSARAKORN MAHAYOTHEE, METHINEE HAEWSUNGCHAROEN, SERM JANJAI, HERMANN LEIS, JOACHIM MUELLER: Effect of Shifting Practices on Performance of a Fixed-Bed Convection Dryer for Longan	87
MICHAL KULIK, JAN BANOUT, BOHDAN LOJKA, ZBYNEK POLESNY, JANA LOJKOVA: Evaluation of <i>Eryngium foetidum</i> L. Processing by Solar Dryers	88
KATHARINE TRÖGER, ANDREAS BUERKERT, OLIVER HENSEL: Conservation of Onion and Tomato in Niger, Assessment of Post-Harvest Losses and Drying Methods	89

SARANYA LAPSONGPHOL, BUSARAKORN MAHAYOTHEE, SARAWUT PHUPAICHITKUN, HERMANN LEIS, METHINEE HAEWSUNGCHAROEN, SERM JANJAI, JOACHIM MUELLER: Effect of Drying Temperature on Changes in Volatile Compounds of Longan (<i>Euphoria longana</i> Lam.) Fruit	90
OLAWALE JOHN OLUKUNLE, OLUWATOYIN FOLAKE OLUKUNLE: Development of a Sustainable System for Cassava Starch Extraction	91
OLAWALE JOHN OLUKUNLE: Development of a Cassava Peeling Machine for Cottage Industries	92
LEO AGBETOYE, OLADIPO OYENEYE: Development of a Harvester for <i>Amaranthus</i> Vegetable	93
SANDRA PATRICIA CUERVO, OLIVER HENSEL: Experimental Determination of Desorption Isotherms for Lemon Balm (<i>Melissa officinalis</i> L.)	94
OLAWALE JOHN OLUKUNLE: Development of a System for Fresh Fruit Juice Extraction and Dispensary	95
MATTHIAS KINDERMANN, KEVIN WEIS, CHRISTIAN LIPPERT, JOACHIM MUELLER: Economic Analysis of Different Processing Methods for Small-Scale Coconut Oil Production in the Philippines	96
ADESOJI OLANIYAN, KAYODE OJE, FOLARIN ALONGE: Development of Process and Equipment for Recovering Clean Shea Kernels from Raw Shea Fruits	97
JOHNSON FASINMINRIN, PHILIP OGUNTUNDE: Development and Calibration of a Digital Recording System for Automation of Runoff Measurement	98
PHILIPP NUSS, SIEGFRIED KLEISINGER, KLAUS BECKER: Investigation of Biotechnical Conditions of <i>Jatropha curcas</i> L. Toward Gradual Harvest Mechanisation	99
THIERRY GODJO: Food Processing Equipment Design in West African Countries: Proposal of a Tool to Provide Better Understanding of the Need	100

Effect of Greenhouse Cooling Method on the Growth and Yield of Tomato in the Tropics

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Cooling greenhouses in the humid tropics is especially challenging due to the high intensity of solar radiation and humidity prevalent in these regions. The effect of natural ventilation and evaporative cooling on the greenhouse microclimate, growth and production of tomato *Solanum lycopersicum* cv FMTT260 were evaluated. The research was carried out in two greenhouses (measuring 20 m long by 10 m wide) at the experimental site of the “Protected Cultivation Project” on the campus of the “Asian Institute of Technology” (AIT), situated 44 km north of Bangkok in Khlong Luang, Pathum Thani, central Thailand, (14° 04' N, 100° 37' E, altitude 2.3 m). The naturally ventilated greenhouse was covered with a UV-absorbing plastic film on the roof and a 50-mesh insect proof net on the sidewalls and roof ventilation opening. The evaporative cooled greenhouse was completely covered with the UV-absorbing plastic film and was equipped with a fan and pad cooling system. In each greenhouse, 300 tomato plants were grown at a density of 1.5 plants m⁻² and maintained for 15 to 20 weeks. Results from two seasons show that the cooling method influenced the greenhouse microclimate, plant growth and yield. Although evaporative cooling lowered greenhouse temperature, the unwanted increase in humidity resulted in fungi infections and reduced transpiration. Plants grown in evaporatively cooled greenhouse were 30 cm to 45 cm shorter than those grown in naturally ventilated one. Differences were also noted in flowering, leaf area, dry matter partitioning and harvested yield. The significance of cooling method and greenhouse covering material on plant growth and production in protected cultivation systems in the tropics is discussed.

Keywords: Evaporative cooling, greenhouse, microclimate, natural ventilation, tomato

Development of a Plant Oil Pressure Stove

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In rural areas of tropical and subtropical countries wood is still the main energy source. Steadily increasing wood consumption for cooking purposes results in deforestation of large areas. This leads to severe ecological, economical and sociological problems. Today, more than 1 billion people face wood shortages.

Cooking on open fires with firewood is often done in poorly ventilated or even closed rooms, which lead to serious health risks for the users. Noxious gases cause eye and lung maladies.

This current situation urgently requires introduction of alternative ways of cooking. Fuel-efficient wood stoves can significantly reduce the firewood consumption but the decrease in consumption will soon be compensated by the fast growing population. Plant oils are a promising alternative energy source offering a variety of economical and ecological advantages. Their utilisation as cooking fuel will assure a sustainable energy supply for numerous communities in developing countries and will secure an adequate food preparation.

At the Institute of Agricultural Engineering of Hohenheim University in cooperation with Bosch-Siemens-Haushaltsgeräte GmbH a plant oil pressure stove has been developed. The plant oil pressure stove can be operated with various plant oils like coconut oil, cottonseed oil, sunflower oil and palm oil as well as with plant oils from different qualities. Just for start-up a small amount of ethanol is required.

During the operation of plant oil pressure stoves it comes to the formation of deposits in the vaporizer pipe. This means the vaporizer has to be cleaned periodically. The formation of residues can be caused by different reaction mechanisms. The amount of residues that are deposited in the vaporizer of the plant oil pressure stove depends on the type of plant oil. Therefore investigations are focused on plant oil ingredients and plant oil parameters, which can influence deposition of residues inside the vaporizer during operation.

Keywords: Cooking stove, energy, plant oil

Development of a Solar Distillation System for Essential Oils Extraction from Herbs

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The limited availability of fossil fuel and their environmental impact, have led to a growing awareness of the importance of solar renewable energy sources especially in tropical countries. Although the utilisation of solar energy is on vast scale world wide yet its application is restricted only to low temperature heating and drying. With the introduction of some innovative medium and high temperature solar collectors during the last decade, it is possible to best utilise the flux of incident radiant energy for food engineering and post harvest processing. Essential oils have been used throughout the world in foods, fragrances, perfumery, cosmetics and medicines. Extracting essential oils from herbs require a distillation process that traditionally uses large, centralised equipment. Such equipment not only requires high operating cost but also is unable to handle extremely delicate plants that must be processed soon after harvesting. Thus, for functional, environmental and economic reasons, there is a need for small-scale, decentralised solar distilling equipment. The main objective of research is to develop and evaluate the performance of solar based distillation system by utilising medium temperature collectors like vacuum tube and parabolic tough collector. The paper describes the first phase of research where a medium temperature solar collector system is installed at Solar Experimental Station, Witzenhausen and tested at different climatic conditions. It also includes results of laboratory experiments conducted with selected herbs to record optimum thermal and physical parameters for the conventional boiler and distillation unit. On the basis of laboratory experiments, the solar collector will be modified with some integrated circuits and auxiliaries to maintain the required thermal parameters. In the second phase of study, complete solar based distillation system will be developed comprising of solar boiler, still tank, condenser, Florentine flask etc and the performance of the complete solar distillation system for essential oils extraction will be evaluated.

Keywords: Distillation, essential oils, herbs, solar collectors

Co-Composting as a Disposal Solution for Faecal Sludge from Innovative Pit Latrines

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A large part of the global population has no access to adequate sanitary facilities. By addressing this issue in the UN millennium development goal 7 this has been recognised as an issue of global concern.

Pit latrines are commonly seen as an affordable and quick to install sanitary solution. Most models, however, do not offer a suitable way to empty the pit. Further anaerobic conditions often cause bad smell and facilitate the breeding of flies. Downstream there is no well thought out disposal solution for the accumulated excreta sludge and nutrients are lost for recycling.

At Valley View University in Accra, Ghana a modified toilet system is currently under investigation. The new design of the so called BBT (Berger Biological Toilet) was developed both user and maintenance personal in mind. Urine is collected separately from the faeces that are sun-dried in aerated mobile containers located below the squatting pan. Thus, the excreta are easily removed and transported without exposing personnel to contamination.

In accordance with the basic principle of ecological sanitation, to return nutrients contained in human excreta into the productive agroecosystems, it is intended to compost the excreta nearby. Preliminary composting trials conducted at the research site revealed that over several days sufficiently high temperatures can be achieved to deactivate most pathogenic micro-organisms. The current research investigates co-composting excreta from two types of dry toilet facilities with shredded vegetation under different ratios and turning frequencies. Physical and chemical parameters are measured during the composting process to detect potential nutrient losses. These include specific weight, dry matter content, nutrient and salt concentrations. Compost maturity is determined by monitoring of temperature and by substrate tolerability to plant development through cress (*Lepidium sativum*) germination tests.

Faecal indicators (*Escherichia coli*, *Enterococci* and *Salmonella* sp.) are monitored and their loads correlated to the heat gradient in the compost piles. The potential deactivation of parasites is validated with *Ascaris suum* egg probes.

It is aimed to identify a simple and fast composting method that conserves most nutrients and reduces the pathogen load to an acceptable level for save agricultural use.

Keywords: Compost, faecal indicators, Ghana, parasites, pit latrine, toilet

An Indirect Passive Solar Dryer for Crop Drying

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A solar drying system designed on the principles of convective heat flow, constructed from local materials and was employed in drying yam (*Dioscorea alata*). The Indirect passive solar dryer consists of a drying chamber at the top of which was a chimney. The chimney is to improve air flow. The solar collector was constructed using a single layer of 4 mm thick glass of transmittance value of 0.63. Other parts include an absorber made of galvanised sheet painted black to absorb the heat energy. Granite stones painted black were also placed on the galvanised metal sheet for heat storage. The drying chamber consists of two drying trays. Air passing through the collector heated up and dried the crop in the drying chamber. The collector was placed at an inclined angle that tallies with the latitude of Ilorin, Nigeria is 8.260 to receive more insolation. Three tests were carried out to evaluate the performance of the solar dryer. The first was a no-load test to know the maximum temperatures attained. The maximum temperatures for the drying chamber, ambient and collector were 56°C, 41°C and 71°C respectively. The second test was to determine the drying rate of yam inside the dryer. Some samples of yam chips, each weighing 1560 g and having an average size of 1 cm thick, were dried both inside the dryer and outside the dryer within its surrounding. The yam tuber was peeled, washed, sliced to about 1 cm and blanched before drying. The initial moisture content of the yam was 70.3% (wet basis) and its final moisture content was 9% (wet basis). The result was compared to natural sun drying. It was observed that the drying time was reduced from 52 hours for sun drying to 45 hours for solar drying. The total cost of the construction was Naira 6,105 (\$50)

Keywords: Collector, drying, moisture content., passive, solar, yam

Investigation of Solar Roof Collectors for Preheating of Air at Drying Facilities in Northern Thailand

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Longan (*Dimocarpus longan* Lour) is an important product in northern Thailand that is a supporting component of the local economy. A significant amount of the annual harvest is dried and commercially exported as a commodity. Conventional longan drying is done in convection dryers at a temperature of 80°C using petroleum fuels for heating the air. Lately, the increasing price of these fuels threatens the competitiveness of Thai longan in the international market. Nevertheless, with the ample solar radiation in Thailand, the roofs of the drying facilities could be adapted to serve as solar collectors to preheat the drying air and reduce the energy requirement from fossil fuels.

In this study, the availability of materials suitable to construct solar collectors, as well as their market prices and relevant optical properties were determined. Ten longan drying facilities were visited to study their general characteristics and configuration, as well as the orientation, surface area and slope of the roofs. Process parameters including actual drying temperature and airflow rate were documented. The simulation software for solar processes, TRNSYS, was used to predict the air temperature rise that can be achieved daily throughout the drying season. Parameters such as local climate, processing conditions and collector characteristics were considered for optimal collector design. For each facility, collector size, duct line requirements, useful heat, collector efficiency and fraction of total energy demand that can be met were determined. According to the price of fuel and its current consumption, the potential monetary savings by using the proposed solar collector were also calculated. Recommendations are given, including a detailed economic analysis to determine the optimum size of collector and materials to minimise costs during the lifetime of the facilities and installed collectors.

Keywords: Solar collector design, *Dimocarpus*, longan, renewable energy, simulation, TRNSYS

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Effect of Shifting Practices on Performance of a Fixed-Bed Convection Dryer for Longan

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Longan (*Dimocarpus longan* Lour) is a seasonal fruit notable for its nutritional and medicinal value that is grown mostly in Asia. Fresh longan has high moisture content and cannot be stored extendedly. Various post-harvest treatments have been found to prolong edibility, but longan is still mainly exported in other forms. Drying reduces the longan weight by approximately 66 % and adds value to the product. However, dried longan must be undamaged and free of contaminants and have optimum colour and moisture content on import. Overall, an adequate and consistent drying process is critical in achieving the standards of international markets. Thailand is currently the largest exporter of longan in the world, a third of which is dried. Production is concentrated in the north, where longan is a major component of the local economy and much of the harvest is dried for export. The most common dryer for longan in this region is the Taiwan-type fixed bed convection dryer, which is used for the bulk drying of unpeeled longan. However, it has been observed that the present design doesn't allow for uniform drying and techniques used to remediate this are labor-intensive and damage the product. So far, little research has actually characterised the performance of this dryer type, or suggested improvements.

Experiments were conducted in Thailand using different shifting configurations compared to the conventional. Drying conditions, energy consumption and product quality were monitored. Results showed that air velocity and temperature were heterogeneous. However, distribution patterns did not correspond. As temperature is highly influential in determining final colour and moisture content of the fruits, product quality was affected. Only samples in the centre positions and the side opposite the air inlet did not show significant differences when compared to a standard sample. High initial relative humidity and convective cooling of exhaust air resulted in condensation on top of the bulk. It was observed that one shifting scheme was superior to the others. To obtain a uniform product in the Taiwan type dryer, the main issues are to create a more uniform distribution of air and temperature in the bulk and prevent condensation.

Keywords: Drying kinetics, flesh colour, fruit drying, moisture content, product quality, taiwan dryer

Evaluation of *Eryngium foetidum* L. Processing by Solar Dryers

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Two solar drying methods (direct cabinet solar dryer and indirect cabinet solar dryer) were tested under tropical conditions for drying sacha culantro (*Eryngium foetidum* L.) in the Peruvian Amazon city Pucallpa. The drying in electric oven was used as reference. *E. foetidum* from Apiaceae family is a perennial or biennial herb native to tropical America. The herb, especially leaves, is used extensively in the Latin America and in Asia mainly as a seasoning in the preparation of a range of foods. Sacha culantro is also widely used in herbal medicines due to its antiinflammatory activity. All around the world culantro is mainly used as fresh vegetable and there is lack of any postharvest processing method especially in the Peruvian Amazon. Thus, the main objective of the work was to investigate the most acceptable drying method in dependence on the final content of aromatic substances and on the applicability of this technology under local conditions. Drying parameters of solar dryers were observed; ambient air temperature and relative air humidity, drying temperature and relative air humidity in the chamber of solar dryers as well as the solar radiation were measured during the experiment run. Dried samples as well as fresh leaves (to enable evaluation of changes on essences caused by drying) were hydrodistilled to obtain essential oils. Oil content in samples was measured and only small losses were recorded in dried samples. Isolated oils were analysed using GC-FID and GC-MS analyses, its components were detected, identified, and relative proportion of compounds was compared. The most important odorants in *E. foetidum* leaves are (E)-2-dodecenal, 2,4,5-trimethylbenzaldehyde, n-dodecanal and (E)-2-tetradecenal. No important distinctions between concentrations of these odour active compounds in essential oil samples were recorded. Demonstrably negative effect of drying was observed on n-dodecanal only. Both direct drying and indirect drying method were evaluated as suitable for drying *Eryngium foetidum* leaves.

Keywords: *Eryngium foetidum*, essential oil, Peruvian Amazon, Sacha culantro, solar drying

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Conservation of Onion and Tomato in Niger, Assessment of Post-Harvest Losses and Drying Methods

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Poor quality onion and tomato are offered frequently on markets in Niamey. A study was conducted in Niamey, Niger between September and December 2006 to assess current post-harvest losses and drying methods of onion and tomato. One major method of conserving perishables is traditional sun drying, which often results in produce of inferior quality. Data on the production, marketing, and quantitative losses of onion and tomato was collected. Moisture content, contamination with sand (acid non-soluble ash), and microbes (total mesophile bacterial count, faecal coliforms, moulds and yeasts, anaerobic living sulphite reducing bacteria), for sun and solar dried onion and tomato, was determined. Finally consumers and retailers were interviewed about their view of produce quality, price considerations, satisfaction levels, stocking behaviour, and preferences.

Final moisture contents varied for dry onion and tomato between 14 % and 16 % with the natural convection solar dryer and 56 % and 22 % with sun drying respectively. Contamination with sand ranged between 0.1 % of the dry matter (DM) for the solar dried produce and 5.4 % DM for the sun dried samples. Samples from the markets contained as much as 20 % DM sand. Only the onion dried with the forced convection dryer and one market sample of dry onion, as well as only one market sample of dry tomato, complied with applied general reference values for microbiological contamination. Quality losses of sold dry onion and tomato to some extent even lead to health risks.

Even though consumer surveys indicate low acceptance of dry onion and tomato, these are commonly used as cheap alternative to fresh produce. Comparative consumer surveys showed that solar dried tomato would be preferred, due to better hygienic quality. Thus need for implementing improved conservation methods is indicated but current socio-economic constraints need to be considered when striving for broad adaptation of new technologies.

Keywords: Consumer, dry onion, dry tomato, food safety, Niger, post-harvest loss, quality, solar drying, sun drying

Effect of Drying Temperature on Changes in Volatile Compounds of Longan (*Euphoria longana* Lam.) Fruit

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Longan is widely grown in South East Asia and China. It is one of the top ten exported fruits in Thailand with an exported value of about 35 million € in the year 2006. It is mostly exported to China, Myanmar and Lao as dried fruit. Longan flesh is used in Chinese medicine for example as a stomachic, febrifuge and vermifuge. Longan flavor is an important quality attribute influencing customers' acceptance especially that of dried product consumed as tea. Therefore, the impact of drying temperature on volatile compounds of dried longan was investigated using a headspace-solid phase microextraction (HS-SPME) coupled with gas chromatography—mass spectrometry (GC-MS). The solid phase microextraction fiber coated with 100 μm mixture of polydimethylsiloxane/divinylbenzene (PDMS/DVB) was applied for the extraction of the volatile components. Longan fruits with peel were dried at 60, 70, 80 and 90°C using a tray dryer with a through flow mode of drying air. The velocity of drying air is constant at 0.2 m s⁻¹. The drying process was carried out until the water activity of longan flesh was approximately 0.55 - 0.60. It was found that major volatile compounds detected in fresh and dried longan were cis-ocimene, beta-ocimene, ethyl acetate and ethanol. Many volatile compounds were produced during drying especially acids, ester and alcohol for instances octanoic acid, ethyl ester, phenylethyl alcohol and 1-octen-3-ol. The retention of cis-ocimene and beta-ocimene was found to be the highest in longan flesh dried at 70°C. The higher drying temperature, the more ethanol and ethyl acetate were detected. Drying temperature is, thus, a crucial parameter causing the different flavor profile characteristic of the dried longan fruit which related to customers' acceptance.

Keywords: Flavor, GC-MS, longan, SPME, volatile compounds

Development of a Sustainable System for Cassava Starch Extraction

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Cassava production in Africa received a major boost due to the joint efforts of African leaders through the New Partnership for Africa's Development (NEPAD). One of the challenges identified by NEPAD is the need to develop technologies for processing cassava in order to reduce post-harvest losses. One major problem associated with cassava processing is low level of mechanisation. In recent times, renewed efforts at improving cassava processing technologies are being made by design engineers especially in Nigeria, Brazil and China. One of the major industrial products from cassava requiring mechanisation is starch. The demand for starch, which is used as raw material in many agro and agro-allied industries, in Africa and Asia is enormous, making adequate investment in the starch industry a necessity. In many developing countries, starch production has been dominated mainly by cottage industries. However, starch extraction by cottage industries is largely done using manual methods. There is a need to develop equipment for small to medium scale starch industries in developing countries. In this study, equipment for starch extraction in one pass of fresh cassava tubers is proposed. The machine consists of a specialised serrated auger, tuber inlet, water delivery system, perforated cage, and an arrangement of sieves, starch delivery outlet, fiber delivery outlet and the power source. The machine is conceived as a low cost equipment to enhance productivity at the small to medium scale levels in developing countries. The major advantages of small to medium scale starch industries is the closeness to the source of raw materials which is cost saving particularly for cassava with about 60 to 70 % moisture content. The highest stakeholders in starch processing are also in this category. It is believed that the equipment would enhance sustainable starch production, reduce human drudgery and promote timeliness of the production process.

Keywords: Cassava, mechanisation, sustainable approach, post-harvest loss

Development of a Cassava Peeling Machine for Cottage Industries

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Timely processing of cassava tubers is important to prevent post harvest losses and ensure food quality. Several processing operations have been mechanised in the production line of cassava products. Peel removal, which used to be a major bottleneck, is receiving attention from design engineers in Nigeria, China and Brazil. Equipment for cassava peeling is now available for small, medium and large-scale cassava processors. However, majority of cassava processors in Nigeria operate cottage industries. Cottage industries in developing countries are generally characterised by low capital investment, manual labour, low production capacity and hence low income. Although cottage industry offers great advantage for developing countries in terms of employment opportunities, it is the most neglected from the viewpoint of credit facilities and mechanisation. In this study a cassava-peeling machine for cottage industries was developed and tested. The cassava peeler consists of a 0.75 kW electric motor, a rotary drum fitted with knives (5 cm long) and a protective hood. This prototype was first demonstrated at the joint African Union-Economic Commission for Africa exhibition in Addis Ababa, Ethiopia. Its simplicity, adaptability, potentials and low-cost attracted African leaders as well as captains of industries. The machine operates on the principle of shear force at relatively high angular velocity of the rotary knife-edge. The rate of peeling with the machine was in the range of 45 kg/h to 80 kg/h. Lower values occurred with lower operator's skill, poor tuber orientation during the peeling process and lower tuber diameter of < 6 cm. Machine capacity was also influenced by moisture content of tubers and variations in length and diameter. These values were higher than those obtained during manual peeling which varied from 20.3 kg/h to 23.3 kg/h and averages 20.3 kg/h. The proportion of peel in the cassava roots ranges from 0.04 to 0.12 and averages about 0.15. The cost of the prototype was estimated at N 13,500 (100 US dollars) but the cost of the proposed commercial model was estimated at N 10,000 (74 US dollars). The machine operates best between a rotary speed of 1000 and 1400 rpm.

Keywords: Cassava peeling, cottage industries

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Development of a Harvester for *Amaranthus* Vegetable

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In Nigeria, leafy vegetables had been mostly cultivated and harvested manually by subsistence farmers. Manual harvesting involve a lot of drudgery, hence with small-scale farmers in mind, a low cost leaf vegetable harvester was designed and evaluated for performance in harvesting *Amaranthus* sp. The main components of the machine are the frame, the reciprocating blade which cuts the vegetables at a predetermined height above the soil. The machine was powered by a petrol engine rated 3 kW, 1440 rpm and the forward momentum was provided by the pushing action of the operator. The performance of the harvester was evaluated in harvesting *Amaranthus* specie (Arowojeja) under various crop, soil and operational parameters. The parameters include moisture content of the soil, crop density, working width and the operating speed of the operator.

The result of the tests performed on the machine shows that it is appropriate for adoption by small scale farmers. Furthermore, it shows that the field efficiency of the machine was influenced more by the moisture content of the soil in the furrows rather than the moisture content of the bed, the speed of the operator and the stage of crop development of vegetable prior to the time of harvesting. The optimum field capacity, harvesting efficiency, collection performance efficiency of 0.07 ha hr⁻¹, 71.5 %, 68.3 % respectively were obtained at operator speed of 0.27 ms⁻¹ and crop density of 1,190,311 plants ha⁻¹.

Keywords: *Amaranthus*, harvest efficiency, harvest mechanisation, harvester

Experimental Determination of Desorption Isotherms for Lemon Balm (*Melissa officinalis* L.)

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The knowledge of the Equilibrium moisture content (EMC), is important for modelling and planning of the drying process and to select the conditions for storage of the product. In this work the desorption isotherms for *Melissa officinalis* L. (Lemon Balm) were determined at four different temperatures (25, 40, 50 and 60°C). In the experiment the method recommended by the project COST 90 (Spieß and Wolf. 1983) was used. This method is based on maintaining a known mass of sample to an atmosphere generated by the use of saturated saline solutions until achieving the balance. The saline solutions were prepared according to DIN 50008 for a range of relative humidity among 10 and 85 %. For the experiment cylindrical containers of glass were used, which were filled until a fourth part with the saturated saline solution. Each sample of 0,5 grams of whole leaves of *Melissa officinalis* L. var. Citronella was placed in a perforated bin of stainless steel, positioned inside the container of glass and sealed tightly. The weight of the samples was registered twice per day, per periods between 10 and 18 days until the samples achieved the balance. It was observed that the moisture content decreases when the temperature for a given water activity is increased. The obtained experimental data were fitted using the following mathematical models: BET, GAB, Halsey, Lagmuir, Oswin, Peleg, Henderson and Chung & Pfof. Using the procedure of non linear Regression and the method of Marquardt with the programme Xact, the experimental data were fitted to the considered models. The chi-square test and the coefficient of determination were used to evaluate the obtained fit. The Halsey's model was found to be the most suitable for describing the desorption curves at temperatures of 25°C and 40°C and BET's model was most suitable for describing the data at temperatures of 50°C and 60°C.

Keywords: *Melissa officinalis* L., desorption isotherms, Equilibrium moisture content EMC, water activity

Development of a System for Fresh Fruit Juice Extraction and Dispensary

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In Nigeria and many other African countries fruit juice is almost becoming a luxury found only on the table of the rich. Processing of raw fruits or juice concentrate into juice is done by large-scale industries resulting in high and unaffordable prices for the low income earners in developing countries. However the need for fruit juice in human diet cannot be over-emphasised. Although, the poor can eat raw fruits, the perishable nature of these fruits underscores the need for processing in order to make fruits available the year round. Locally available fruits that are widely grown in Nigeria include cashew, mangoes, watermelon, guava, pineapples, paw paws, oranges, tomatoes, tangerines, and many other indigenous fruits. Production of fruits in Nigeria can be estimated at hundreds of thousands of metric tones per year. Unfortunately, over 50 % are lost due to perishable nature of fruits occasioned by high moisture content and poor post harvest handling and marketing strategies.

In this study, a system for handling, processing and preservation of fruits was developed and tested. The system consists of the washing unit, the juice extraction unit, juice filtration, conditioning unit and dispensary unit. The system was packaged in a way to make juice available in the fresh form for consumption. Fruits such as orange, mango and pineapple could be processed to obtain 100 % juice. A combination of one or more fruits is feasible to obtain mixed fruits. The systems provides for quick processing and dispensary of fresh fruits at affordable prices. The system has been introduced to some schools, villages, establishments and corporate organisations in Nigeria. Results show that majority accepted the product readily because of its positive health implications of fresh fruit without additives/preservatives. The equipment used is affordable to small-scale industrialists. Thus, the system offers a sustainable approach for processing and consumption of fresh-fruit juice in developing countries. It is believed that the adoption of this system would enhance healthy living among the rural poor, provide employment, promote industrialisation and food security. The initial cost of the system was estimated at 1,500 US dollars

Keywords: Fresh-fruits, juice extraction, pineapple, mango

Economic Analysis of Different Processing Methods for Small-Scale Coconut Oil Production in the Philippines

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Due to a fast growing Philippine population, the demand for household fuel is increasing. Local coconut oil production on small-scale level may offer an economically feasible alternative. The objective of the present study was to analyse whether coconut oil produced on household level can be competitive with current kerosene prices.

Three small-scale (wet) oil processing methods (i) traditional kitchen method, (ii) modified kitchen method and (iii) virgin oil method as well as three medium-scale oil presses (i) Strähle SK 60/2, (ii) Montforts Komet DD 85 G and (iii) Philippine Simplextractor were evaluated by calculating unit costs, net present values (NPV) and periods of amortisation. Possible revenues from by-products were considered in the calculations.

Among the wet methods the traditional kitchen method had the lowest net oil yield (471 a^{-1}) and the highest unit costs ($1,253 \text{ PhP l}^{-1}$). The best performance attained the virgin oil method reaching a net oil yield of 4971 a^{-1} along with unit costs of 83 PhP l^{-1} . All NPVs were negative.

Copra produced from fresh nuts which is used in the expellers turned out to be the best solution since costs can be reduced by selling by-products. Highest unit costs amounted to 44 PhP l^{-1} in case of the Strähle expeller (capacity: $16,000 \text{ l a}^{-1}$). Lowest unit costs occurred with 24 PhP l^{-1} using the Simplextractor (capacity: $43,700 \text{ l a}^{-1}$). The latter was identified as the most profitable investment. The assumed setup generated a NPV of $2,411,437 \text{ PhP}$ and resulted in a period of amortisation of two years.

The wet methods were not economically feasible with the assumed setup. By contrast, the establishment of processing centres using the Simplextractor can be recommended. The obtained oil can be a competitive household fuel as long as its unit cost is lower than the kerosene price in Leyte which was 36 PhP l^{-1} in November 2005.

Keywords: Coconut, cooking fuel, oil production, plant oil, small scale

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Development of Process and Equipment for Recovering Clean Shea Kernels from Raw Shea Fruits

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Shea fruit is made up of a green epicarp, a fleshy mesocarp (pulp) and a relatively hard shell (endocarp) which encloses the shea kernel (embryo). The kernel contains about 60 % edible fat (shea butter) and the residual product, from which the butter is extracted (shea cake), is an excellent ingredient for livestock feed production. Shea butter is gaining popularity in soap, cosmetic, pharmaceutical, medical and engineering industries for the production of toilet soaps, pomade, drugs, ointments and metal cutting fluids respectively. These products in Nigeria have a lot of potential for export. Based on information available from literature and laboratory investigations conducted towards obtaining quality shea kernels, an improved process line was developed to process raw shea fruits in the form of clean shea kernels to be used as raw material for shea butter production. The process line consists of parboiling the shea fruits to deactivate contaminating enzymes and micro-organisms and then remove the toxic and antinutritional agents, washing the parboiled shea fruits to produce clean and sterilized shea nuts and drying the shea nuts to a moisture content of about 6 % (wet basis). The process line continues with cracking of the dried shea nuts and separation of clean shea kernels from broken shea shells. Then clean shea kernel is roasted prior to shea butter extraction. Three specific purpose process equipment were developed for the process viz: a shea nut parboiler, a cracking machine with a separating unit and a shea kernel roaster. The parboiler is capable of parboiling 70 kg of raw shea fruits at a batch while the cracking machine has an average efficiency of 89 %. The roaster has a capacity of 20 kg hr⁻¹ and average performance efficiency 72 %. The shea kernel produced by this process has about 60 % fat with no urease activity and can be an excellent raw material for shea butter extraction mill. A small scale shea kernel recovery plant based on the process line developed in this study using the above three equipment can provide employment for three rural labourers at the market price of shea kernel.

Keywords: Shea fruit, shea butter, oilseed, mechanisation

Development and Calibration of a Digital Recording System for Automation of Runoff Measurement

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The measurement of surface water flow (runoff) by the use of ICL7106 Digital converter is a new concept of runoff measurement in the developing countries. It is a very efficient, low power analog to digital (A/D) converter. The necessary active devices used for the development of the digital recording system include decoders, display driver, reference resistor, a clock, sensor, liquid crystal display (LCD) and ICL7106. The ICL7106 is designed to interface with a liquid crystal display (LCD), which includes a back plane drive. A runoff collector of area 1m^2 and depth 30 cm was constructed, and a discharge pipe, 2.5 cm diameter and 60 cm length conveys the runoff into a storage tank, 30 cm \times 30 cm \times 30 cm in dimension. Both the runoff collector and the storage tank were made of metal sheet (gauge 12). This equipment was designed to measure the amount of runoff that flow into the runoff storage tank through the discharge pipe, such that the resistor sensed runoff according to the level of water in the tank. The sensor divides the reference voltage V_r in ratio to the value of resistance (R). This varying voltage is now converted to digital readout by A/D converter with respect to liquid crystal display (LCD). The device was calibrated using the measuring cylinder and a high correlation coefficient was obtained between the records of the digital sensor and the water depth measured with the use of measuring cylinder ($R^2 = 0.89$). The relationship between the sensor value and the water depth was of the form $y = 2504.2x - 17693$. This research development is useful in weather forecasting, flood and hydrological analysis in natural science studies.

Keywords: Digital recording system, surface water, runoff

Investigation of Biotechnical Conditions of *Jatropha curcas* L. Toward Gradual Harvest Mechanisation

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Jatropha curcas L., a multipurpose plant of the tropic and subtropic climate, is a source for manifold products. These days it is in focus as a potential energy crop for degraded soils in India and other similar climates. For a prospective and efficient large scale seed production a gradual harvest mechanisation of the crop is required.

In regard to this, basic data about plant and fruit specific attributes was collected on three plantations of the Central Salt & Marine Chemicals Research Institute in the state of Orissa in India.

First, a grading system to discern the different maturity stages by means of the fruit colour was developed. Hereupon about 1000 fruits from three different localities and genotypes in six stages of maturity were experimentally harvested.

According to maturity, measurements of the retention force, fruit diameters and fruit mass as well as an oil content analysis were practised. Further two experiments with an experimental “coffee shaker”, a vibration harvesting device were done.

Based on those data the volume, density, sphericity and terminal velocity of the fruits was determined. A significant relationship of a decreasing retention force during progressive fruit maturity was found. The genotype had no significant influence on the retention force.

In seeds from immature fruits the oil content was significant lower than in seeds out of the ripe classes.

The experiments with the shaking device showed that a harvesting technique based on a vibration method is potential but also causes injuries on the plant and needs further adjustments to the culture.

Keywords: Biotechnical conditions, harvest technique, *Jatropha curcas*, mechanisation

Food Processing Equipment Design in West African Countries: Proposal of a Tool to Provide Better Understanding of the Need

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Over the last decades, various attempts have been made in Benin, as in most West Africa countries, to improve production techniques for the food processing of agricultural products, by introducing production equipment to do the work previously carried out by women. However, it is clear that a lot of equipment failed in this sector. It's because the design of these equipment very often suffer from a lack of tool, that would make it possible to take into account very early in the design process all the various aspects of the future equipment: food processing, food composition, user expectations, using and maintenance constraints, life cycle cost, etc. To improve the design of food-processing equipment, two design experiments were carried out in Benin. The design activities were performed according to the recommendations of the "CESAM" method (equipment design for developing countries) and with the additional back up of the Participatory Design, the Scenario Based Design and the User Centered Design. The data collection and analysis method was based on an approach inspired by ethnographic techniques. My paper will provide a tool, the Functional Understanding Diagram (FUD), which I have proposed allowing better understanding of the conventional process and therefore the need. The FUD is made up of three columns. The middle column gives a description of the operation performed manually by the women. The left-hand column contains text pointers with a summary description of the operation and text explaining why the function exists. The right-hand column contains digital pointers to photos and videos of the operation.

Keywords: Food equipment design, Food processing

Land use and livelihood strategies

Oral Presentations	103
MOHAMMAD ASIF KHAN: Factors Affecting Employment Choices in Rural Northwest Pakistan	103
STEPHANIE BARRAL, ELSA PONCET: Transmigration Policies and Rural Development in South Sumatra: Comparative Study of two Villages	104
IDHA WIDI ARSANTI, MICHAEL BÖHME, HANS E. JAHNKE: Resource Use Efficiency and Competitiveness of Vegetable Farming Systems in Upland Areas of Indonesia	105
BERND HARDEWEG, HERMANN WAIBEL, SUWANNA PRANEET-VATAKUL, PHUNG DUC TUNG: Sampling for Vulnerability to Poverty: Cost Effectiveness Versus Precision	106
Posters	107
GÜNTER BURKARD: Cocoa and Rural Transformations: Processes of Displacement and the Emergence of Agrarian Arrangements in Central Sulawesi, Indonesia.	107
GÜNTER BURKARD: Conservation Agreements as an Institution for the Commons: Contexts, Situations and Consequences Evidence from the Napu and Kulawi Valleys, Sulawesi, Indonesia	108
RASHMI NARAYANA, CHANDRAKANTH MYSORE, M.V. SRINIVASA GOWDA: An Environmental Economic Assessment of Sujala Watershed Project in Tumkur District	109
ABDALLAH DIOP, CHRISTIAN RICHTER: Opportunities and Constraints of Urban and Periurban Agriculture — A Case Study of Vegetable Production in N'Djaména	110
YANJIE ZHANG, BERNHARD BRÜMMER: Economic Efficiency and Land Rights –A Stochastic Frontier Analysis of Agricultural Production in China	111

KAREN TSCHERNING, HEITOR COUTINHO, HANNES KÖNIG, KATHARINA HELMING, LIN ZHEN, STEFAN SIEBER: Ex-Ante Sustainability Impact Assessment of Multifunctional Land Use - Case Studies in China and Latin America	112
ISRAT RAYHAN, ULRIKE GROTE: Floods in Bangladesh: Does Crop Diversification Mitigate Vul- nerability of Rural Households?	113
VLADIMIR VERNER, PETRA HOLIKOVA, JIRI PACESNY: Using Gini Coefficient as a Tool for Including Income Inequal- ity into Human Development Index	114
HEIKO ZELLER, MATTHIAS VON OPPEN: Socio-Economic Impact of Upland Rice Production on Rural Livelihoods — The Case of Three Nigerian States	115
EVELINA BUDJUROVA, SIEGFRIED BAUER: Efficiency Analysis of Wheat Producing Farms in Tashkent Region, Uzbekistan	116
REGINA SCHOELL, CLAUDIA R. BINDER: Perspectives of Farmers and Experts Regarding Future Agri- cultural Development: Results from a Future Structured Men- tal Model Approach	117
SHEPHARD SIZIBA, FRANZ HEIDHUES, MULUGETTA MEKURIA: A Comparative Economic Analysis of Conservation Tillage and the Mouldboard Plough in Zimbabwe's Subsistence Farm- ing Sector	118
CORAL MONJE, JUAN GUILLERMO COBO, GERD DERCON, GEORG CADISCH, ROBERT DELVE: Biophysical Factors Affecting Maize Productivity of Small- Scale Farming System under Three Settlement Schemes in North-East Zimbabwe	119
NILS TEUFEL, OLAF ERENSTEIN, ARINDAM SAMADDAR: Perceptions and Potential of Resource Conserving Technolo- gies in the Crop-Livestock Systems of the Indo-Gangetic Plains	120
GODIHALD MUSHINZIMANA: Improvement of Food Security and Income through Utilisa- tion of Marshlands in the Province of Gitarama (Rwanda)	121
JEAN ADANGUIDI: A Comparative Analysis of Land Use Systems in Benin	122

Factors Affecting Employment Choices in Rural Northwest Pakistan

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Using the multinomial logit model, this study explores the factors affecting occupational choices in rural northwest Pakistan. The study uses census data of 2825 households in six villages of Peshawar district Pakistan collected by an interdisciplinary research team of Göttingen University, Germany. The results comparing six distinct occupations versus non-farm informal activities suggest that asset endowment of households has a significant effect on households' head choice of employment. Livestock holding increases the odds of practicing farm related occupations relative to informal wage activities. Wealth, defined here as household per capita income, matter a lot in the likelihood of pursuing occupations other than informal activities in northwest Pakistan. Similarly, the likelihood increases for household with fairly younger and illiterate heads to engage in non-farm informal sector. Household size is positively and significantly related to all the occupational groups while an additional working member reduces the odds to work as farmer. Credit and farm land constraint also drive households into informal jobs. Finally, comparing the six villages in term of labour market, we find that business activities are significant in villages with better infrastructure. Due to lack of natural, financial and human capital more and more people in the study area have to find their livelihood in the informal casual sector. However, majority of these non-farm activities are survival oriented and have little to do with wealth accumulation. The implication of the study is that rural non-farm sector needs its due share in development policies as it has the potential to uplift the rural areas.

Keywords: Informal employment, multinomial logit, Northwest Pakistan, occupational choices

Transmigration Policies and Rural Development in South Sumatra: Comparative Study of two Villages

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Throughout the 20th century, Indonesian governmental migration policies have had serious repercussions on the rural development of thinly populated islands like Sumatra. In the 1980s, the French research institute ORSTOM (now IRD) conducted several studies to analyse the impacts of these population movements on the rural system of the southernmost province of Sumatra, Lampung. This province has been subject to particularly high population flows that varied depending in the geographic location. Whereas the peneplains and the piedmont of the Barisan Range were soon colonized, the colonisation of the mountainous parts was delayed and only accelerated in the 1970s.

This study aimed to understand the influence of this colonisation gradient on rural dynamics, on agricultural activity, and more generally on social and economic dynamics. Two villages were chosen as a function of this gradient and studied.

In Bengkulu, which is located in the piedmont of the Barisan Range, environmental conditions are suitable for production of pepper, coffee and rubber. In Giham, which is located in the upland of the Barisan, a cooler climate allows the cultivation of coffee and European vegetables.

Both villages were settled as a result of two migration flows; a first one of Sumatranese migrants, and the second bigger one of Javanese people, who provided a source of labour for the first. The main differences in the historical changes that took place in the two areas were due to the fact that they occurred in different periods of time, and with varying intensity. But for both of them, diversification appeared as a vital strategy to face increasing land pressure, price volatility of cash crops and pressure from plant diseases.

Diversification was also partly a response to the risk of disease and to the volatility of the price of cash crops. In Giham, some farmers took advantage of market gardening, and the village experienced an important economic upward trend. On the contrary, in Bengkulu, the numerous failures of pepper production no longer enable decent living standards; and the inhabitants of the area are barely in a position to develop new crops, due to the disruption of the social balance.

Keywords: Agrarian systems, Indonesia, migrations, rural economy, rural sociology

Resource Use Efficiency and Competitiveness of Vegetable Farming Systems in Upland Areas of Indonesia

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Rapid population growth and increased incomes are raising the demand for vegetables in Indonesia. The problems of low growth in production and high fluctuation in import and export volume and price can be attributed to a multidimensional crisis. In order to overcome these problems, it is first necessary to analyse resource use and competitiveness of Vegetable Farming System (VFS) using accounting standards based-on domestic resource cost and Policy Analysis Matrix (PAM) including private cost ratio (PCR) and domestic resource cost (DRC).

The information and data from the literature were not sufficient to get answers to all the problems. Therefore it was necessary to collect primary data in the investigated regions. This data collection was conducted in three vegetable production centres in upland areas in Pangalengan, Keajar and Berastagi-Simpang Empat. Then it was applied to a respondent classification based-on type of vegetables in each region. In each village 25 respondents (50 respondents in the two villages) were interviewed. The number of all respondents in all regions was 150 farmers.

Results suggest that VFS in upland areas of Indonesia is the important income activity of the farmers and that they use resources efficiently and are conscious of the competitiveness of the vegetable crops. It could be seen from PCR and DRC values which were below 1. Potato, headed cabbage in Pangalengan and in Keajar, tomato and carrot are mainly competitive in Berastagi-Simpang Empat. This can be explained as follows: farmers use chemical inputs at a higher rate than its recommendation, cost per unit is high, productivity is low and farmer's accessibility to the market and fluctuating price is limited. Headed cabbage cultivation in Berastagi-Simpang Empat still needs support from the government.

Based on the results, it can be concluded that some of programs are necessary to be created by the government in order to support the development of VFS in upland areas, especially for potato and cabbage based-on the agro ecosystem or infra structural in each region. The results of the research are of general importance for economically evaluation of VFS in upland areas of South-East-Asia.

Keywords: Competitiveness, resource efficiency, vegetable farming system

Sampling for Vulnerability to Poverty: Cost Effectiveness Versus Precision

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Previous studies to measure poverty were based on a static concept of poverty and relied on cross-sectional data for income or consumption expenditure over relatively short periods of time. Static poverty is generally expressed by indicators such as the headcount ratio and the poverty gap. Recent research however has established that these indicators are rather imperfect proxies for the well-being of poor households and insufficient for devising effective strategies of poverty reduction. Instead, the dynamic nature of poverty must be captured by measures with a predictive capacity to recognise the fact that a household not being poor today might yet be vulnerable to falling into poverty as a result of covariate (e.g. natural disasters, financial crises) and idiosyncratic (e.g. death, unemployment) shocks. As vulnerability of a household is a function of **(a)** occurrence and severity of risks and shocks and **(b)** its ability to cope through *ex-post* and *ex-ante* mechanisms (e.g. insurance, credit markets, social institutions) an assessment of vulnerability requires panel data of a large sample of households which are either poor or face the risk of being poor in the future. Collecting such information is a challenge given usually insufficient prior information.

This paper reports the sampling procedure for vulnerability assessment used in the DFG research project (DFG-FOR 756), which aims at advancing the vulnerability concept by establishing an empirical database for 4400 rural households in three provinces in Thailand and Viet Nam. A questionnaire capturing sources and use of annual household net income on the one hand and measuring the effect of past shocks as well as perceived risks on the households' current consumption, income and wealth has been developed and intensively tested. A multi-stage sampling procedure was adopted with probability proportional to size in all but the last stage, in which clusters of a fixed size of 10 households per village were sampled.

In order to capture the higher level of heterogeneity in agro-ecological, economic and demographic conditions, additional criteria such as ecological and economic zones and disproportionate sampling were used for Viet Nam.

Initial testing of the data revealed the option to test several models of vulnerability.

Keywords: Household survey, sampling, Thailand, Viet Nam, vulnerability to poverty

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Cocoa and Rural Transformations: Processes of Displacement and the Emergence of Agrarian Arrangements in Central Sulawesi, Indonesia.

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This paper analyses the emergence of exclusive rural labour institutions in a village in the forest margin of the Lore Lindu National Park in Central Sulawesi, Indonesia. Within the last decade, the Lore Lindu area experienced an unprecedented cocoa boom resulting in an enduring reconfiguration of the agrarian structure. The cultivation of cocoa is dominated by immigrants from South Sulawesi who established themselves as the most economically powerful group through a systematic and continuous process of land accumulation. Within this process, most of the village's wet rice lands have been converted into perennial estates. This had deep effects on the village internal labour market because, once established, cocoa plantations could easily be managed by household labour. Thus, indigenous "work sharing groups" broke down as collective work activities were not anymore necessary in dry field cultivation. Cultivators of rice fields on the other hand could no longer rely on a stable work force formerly provided by the work groups as an increasing number of "free riders" withdraw their involvement in transplanting and harvesting. Thus, landowners started to secure their work force on the basis of "deferred gratification" with each parcel of wet rice being exclusively planted and harvested by the same person. These arrangements provide job security and serve as a redistributive mechanism for a significant part of the local population. In contrast to the case of Java where such arrangements produced a split between those with a secure access to work and those who became pushed out of agriculture, exclusive arrangements in highland Sulawesi are better described as a form of "shared poverty" among the indigenous population. This case study shows that non-capitalist work institutions do not only often outlive the commercialisation of the countryside but may even be created as a consequence of capitalist expansion. Likewise, "shared poverty" is not a feature of a remote traditional past, but the outcome of a contemporary rural differentiation induced by market penetration.

Keywords: Agrarian change, cocoa, forest conversion, rural labour markets, Indonesia

Conservation Agreements as an Institution for the Commons: Contexts, Situations and Consequences Evidence from the Napu and Kulawi Valleys, Sulawesi, Indonesia

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Because the delineation of the Lore Lindu National Park in Central Sulawesi as “prohibited area” had disastrous results due to a significant lack of legitimacy in the eyes of the local communities bordering the park, since August 2002 the state has altered its strategy in granting more management authorities to the villages at the forest margin via negotiated arrangements. National laws regulating natural resource management in direct ways (Forestry Law UU 41/1999, Conservation LAW UU 5/1990) offer almost no room for autonomous resource management. The Agrarian Law UU 5/1960 and the “Regulation on Land Conflicts” (PP 5/1999) confine management rights only to “customary law communities” The problem lies in the fact that customary forests” are often secondary forests formerly embedded in cyclical agricultural systems. Thus, the devolution of rights must rely on laws regulating NRM in indirect ways with the effect that the CCA are not recognised by the Forest Department and have thus only a low legal reliability. As “Institutions for the Commons”, the reliability and sustainability of these so-called conservation agreements are less determined by their specific “design principles”, but rather by the social and political environments in which there are embedded. These, in turn, are primarily defined by: 1 The legal framework for devolution provided by the Indonesian legislation, 2. The wider reformative discourses on “indigenous rights” and “people’s economy” in general and 3. The coexistence of contradictory perceptions of property rights existing in the research area as well as in the Indonesian statutes. Being faced with different local situations, people draw upon different legal and property discourses in order to legitimate their claims. These, in turn, have significant impacts on the perception of socio-economic security. The contribution should further help to identify several “key variables” of agreements which should allow for a systematic comparison. Important contextual aspects of the conservation agreements in Central Sulawesi are (1) the genesis of the agreements, (2) leaders’ policies, (3) legal base and perceptions of property rights, (4) programme implementation and (5) ideological outlook of facilitating NGOs.

Keywords: Conservation agreements, devolution, local resource management, national park management, Indonesia

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An Environmental Economic Assessment of Sujala Watershed Project in Tumkur District

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This study attempts to assess the environmental economic impact of Sujala watershed programme in Karnataka on groundwater recharge, the resultant efficiency and equity in the distribution of benefits. Field data were collected for the year 2004–05 from 30 farmers each in the upstream and downstream areas of Devarathorehalla watershed while 30 farmers in non-watershed area were chosen to represent the control. Field data from Sample farmers were classified based on physical access to groundwater as low, medium and high water users. Annual externality was worked for both inside and outside watershed areas to ascertain the differing degrees of predicament suffered by farmers.

In the watershed, physical access is higher by 17 per cent (12.31 acre-inches) compared to non-watershed area (10.56 acre-inches). Environmental economic impact of Watershed Development Programme included savings in cost of groundwater irrigation and augmented net returns to groundwater. The irrigation cost was found to be 15 per cent lower in the watershed (Rs. 171 per acre-inch) than in the non-watershed (Rs. 201 per acre-inch). The amortized cost per functioning well was 14.5 per cent lower in watershed (Rs. 13,109) than in non-watershed (Rs.15, 392) and the investment per well in Sujala was Rs. 47,276 lower than that in non-Sujala being Rs. 62,728, by 25 per cent. The investment per functioning well in the watershed was Rs. 64,785, i.e., 14 per cent lower than that in non-watershed (Rs. 75,273). The net returns per acre of gross irrigated area was Rs.5,064 for low water users, Rs. 3,988 for medium water users and Rs. 4,430 per acre for high water users.

Comparing Gini Coefficients in respect of the distribution of net returns per farm (0.7 Vs 0.76), in the watershed there was greater equality compared to outside watershed. The annual net returns per acre from all sources in watershed were Rs. 3,769, higher by 31 per cent over the non-watershed (Rs. 2,869), reflecting the synergistic contribution of Sujala watershed programme enlisting the participation of NGO's and farmers.

Keywords: Watershed, groundwater

Opportunities and Constraints of Urban and Periurban Agriculture — A Case Study of Vegetable Production in N'Djaména

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Demographic growth and increase in urbanisation are some of the challenges in regard to urban and periurban Agriculture (UPA). N'Djaména, the capital of Chad, has grown rapidly in recent years and today has an estimated population of nearly one million people. Accordingly, in the past decade the consumption of vegetables in N'Djaména increased and reached currently about 30-45 kg person⁻¹ year. Vegetable production in N'Djaména's peri-urban and urban areas makes an important contribution to both food demands and nutritional needs of the urban population. It also provides a regular income to producers throughout the year and has a positive impact on public health.

The objective of this present study was to gain an overview of urban and peri-urban agricultural practices by analysing at first its institutional, technical, agronomical and other constraints, followed by examining the social and environmental positive aspect of UPA for vegetable growers in N'Djaména and finally to propose recommendations. Data were obtained from the survey by administering a standardised questionnaire to 5 randomly selected associations of vegetable producers within and in the fringe of N'Djaména. Supplementary data were collected through key person interviews (n = 120) and field observations. The cultivated vegetables, which this study considers, are tomato (*Solanum lycopersicum*) and salad (*Lactuca sativa*).

The result shows that the main driving forces for vegetable producers to become engaged in urban agriculture are food security and income generation. The availability of land is very often (particularly along the Chari River) the crucial element for people to become occupied in UPA, but even more so is its access. The survey has shown that about 20 % of the producers are owner of their land and availability of and access to input (such as seed, fertilisers, herbicides, etc.) and irrigation water constitute a limitation of production by more than 40 % of producers. The study established that because of important social role of UPA, 95 % of the interviewed vegetable producers desire to continue their activities.

Keywords: Chad, urban agriculture, peri-urban agriculture, vegetable production

Economic Efficiency and Land Rights –A Stochastic Frontier Analysis of Agricultural Production in China

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The rural reform started at late 1970s improved farmers' incentives and has had great impacts on China's agricultural production and productivity growth. Many empirical studies show that, while the productivity improvement and technological progress are spectacular over the last two decades, the performance of efficiency change is not so inspiring, and there seems to be lack of greater institutional incentives to arouse farmers' enthusiasm for agricultural production when entering the 1990s. Meanwhile, the remaining ambiguity over land tenure rights seems to show a robust explanation power for the source of unexpected efficiency performance. Considering the hot dispute about institutional reform related to land issues currently in China, whether it is the suitable choice and right timing for the creation of new institutions will also be an interesting topic to explore.

This study will estimate the productivity change and efficiency change of China's agricultural production since the reform, from an institutional environment perspective. Specifically, we are trying to explore how effective the existing land tenure and related property rights systems have been in providing households with incentives to ensure the development of agricultural production and productivity progress, to what extent they have impacted the farmers' efficiency.

In our case, total factor productivity (TFP) is decomposed into three components: technical change, technical efficiency change and a scale effect.

Stochastic frontier analysis (SFA) approach is used to obtain estimates of productivity change and its components. A translog specification of the production frontier is applied in our study, and the parameters are estimated using the maximum-likelihood (ML) method.

Here we apply aggregated provincial level data for the 1979–2000 period to a translog production frontier model to calculate indices of TFP change and its three components and explain the variation in technical efficiency.

Keywords: China, economic efficiency, land rights

Ex-Ante Sustainability Impact Assessment of Multifunctional Land Use - Case Studies in China and Latin America

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The EU Integrated Research Project SENSOR, develops ex-ante Sustainability Impact Assessment Tools (SIAT) to support decision making on policy options related to land use especially in European regions. After two years project duration focussing on European land use policies, SENSOR recently integrated six additional partner institutes from China and Latin America into the Consortium. The challenging task during the next two years will be to test the validity of European Ex-ante Impact Assessment Approaches and the adaptability of the developed SIAT in extra European regions. With China, Brazil, Argentina and Uruguay, SENSOR focuses on those countries, whose land use sectors are highly dynamic and of particular importance for the world's sustainable development.

SENSOR will develop a comprehensive concept for the elaboration of integrated Sustainability Impact Assessment Tools and formulate relevant future scenarios of possible land use options. "Sustainability choices spaces" will indicate to the decision maker the room for manoeuvre with regard to Sustainable Development. On the basis of the Driver-Pressure-State-Impact-Response (DPSIR) approach, region specific driving forces will be analysed and a set of sustainability indicators will be compiled. The identification of land use functions will give special importance to land use sectors and their respective functions from different stakeholder perspectives. Causal chain relationships between policies, land use changes and sustainability issues for relevant impact issues will be identified and integrated into the SIAT.

In China two regions with extremely contrasting sustainability issues have been chosen: **(a)** the Mentougou district in the western hills of Beijing, a mountainous terrain supplying Beijing with agricultural products and **(b)** the Guyuan district (Ningxia), which is considered as one of the poorest regions in China. In Latin America SENSOR focuses on the La Plata River Basin, a region with an outstanding high number of threatened ecosystems (Pantanal, Atlantic Rainforest, Cerrado, Chaco, Pampas).

SENSOR offers a platform for exchange among researchers and experts from government, economy and civil society from Europe, Latin America and Asia on experiences with sustainability issues and ex-ante impact assessment on land use.

Keywords: China, decision support system for policy making, Latin America, land use changes, sustainability impact assessment

Floods in Bangladesh: Does Crop Diversification Mitigate Vulnerability of Rural Households?

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The frequent occurrence of disastrous flooding causes heavy loss of human lives and crop damage in Bangladesh. This study is set forth to examine vulnerability to floods and to investigate how households cope with different kinds of floods in rural areas of Bangladesh. Vulnerability estimates focus on households who rely on different income sources, and deal with the question to what extent crop diversification is an option for mitigating flood risk for farmers. It is hypothesised that more vulnerable farming households are more likely to choose traditional crops over riskier but more profitable new varieties. The analysis is based on primary data from a cross sectional household survey, being conducted just two weeks after monsoon and flash floods had occurred in the rural areas of four districts of Bangladesh in 2005. A two stage stratified random sampling technique was applied both in flooded and non-flooded areas and 1050 rural households were selected and interviewed. We first estimate vulnerability based on the expected poverty method by Chaudhuri, Jalan and Suryahadi (2002). For these estimates on (idiosyncratic and covariate) vulnerability, demographic, socio-economic, shock (flood), coping and community factors were regressed on the monthly income and consumption (per capita and adult equivalence scale by Townsend 1994) of the sample households. The results show that in overall sample, 55 % of the households are observed to be poor but 62 % are estimated to be vulnerable, while among the non-poor households, 7 % count as highly vulnerable. For flooded households, the risk of falling below the poverty line, is significantly higher compared with the non-flooded households. The flash flood causes 1.28 times higher covariate vulnerability than idiosyncratic risk. In addition, the monsoon flood causes more damage in cash crop (jute) whereas flash flood is risky for staple crop (paddy).

Keywords: Covariate risk, crop diversification, flood, idiosyncratic risk, rural households vulnerability

Using Gini Coefficient as a Tool for Including Income Inequality into Human Development Index

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Human (or socio-economic) development, as the ultimate goal of the development process, is recently widely measured by Human Development Index (HDI), which is annually calculated by UNDP in Human Development Report for approximately 180 countries. This indicator consists of three different categories: quality of life, achieved education and descent standard of living. The level of life standard is expressed by Gross Domestic Product (GDP) per capita in US-dollars and purchasing power parity, but this indicator is not able to line up how is income distribute between the population. It makes difficult to measure human development in countries, where GDP per capita is very high, but major part of population is still very poor as field studies always shows. If HDI went beyond GDP per capita in developing countries classification in 1990s, the challenge now is to go beyond HDI and find out the tool that help us to classify developing countries more detachedly. Gini Coefficient seems to be a good tool. Question is how to include its value into HDI formula. Two ways are presented in this study: via exponent function, which seems to be more appropriate or by creating complex indicator together with GDP per capita, where the calculation is more difficult as the weight of Gini Coefficient on Life Standard indicator could be disputable and not just the question of mathematics. The presumption is, the Gini Coefficient and GDP per capita should play equal role in the indicator for measuring Life Standard. There is also one critical point, namely Gini Coefficient data collection, which seems to be still very difficult. However, results shows, that Gini Coefficient including into HDI provide us with better numbers for developing countries classification.

Keywords: Economic growth, Gini coefficient, human development index, income inequality

Socio-Economic Impact of Upland Rice Production on Rural Livelihoods — The Case of Three Nigerian States

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Rice has traditionally been an important and basic food commodity for certain populations in West Africa. In Nigeria, of all staple crops rice has grown in importance as a component of Nigerian diets. Since the mid-80s Nigerian consumption has increased tremendously at almost 11 % per annum, which is a greater increase than in any other West African country. The recent growth in rice demand is creating opportunities for small scale producers. Upland rice is largely produced by subsistence-oriented resource poor farm households. The use of external inputs such as mineral fertiliser is not common. As the crop is subject to climatic conditions the results are more uncertain than those of irrigated rice.

The relevance of upland rice production for households is outlined by using rural livelihood analysis tools. The framework places emphasis on the assets and gives a review of what people have or have access to. Resource endowments, income portfolios and corresponding livelihood typologies are identified to show the relevance of rice in view of specialisation or diversification strategies. The analysis refers to three regions which are situated in the south-west, middle belt and south east of Nigeria. Results indicate that the resource endowment and diversification level vary along a south east gradient. Rice producing households are primarily smallholders with limited assets. The acreages of upland rice are around 1–1.3 ha which make up 25 % up to 49 % of the cultivated farmlands in the key sites. The specialisation level in view of livelihood typologies is low and only worth mentioning in the middle belt key site. Upland rice is, first and foremost, a cash-crop and accounts for approximately one-third of the cash income in each state. Consequently, rice cultivation is of particular importance for the income portfolio. With increasing diversification and in view of off-farm business, cash incomes are higher. This might implicate that better-off households have the ability to utilise farm or particularly non-farm sources of cash income to purchase inputs like mineral fertiliser and improved varieties.

Keywords: Income portfolio, rural livelihood analysis, upland rice production

Efficiency Analysis of Wheat Producing Farms in Tashkent Region, Uzbekistan

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After achieving independence in Uzbekistan, government agricultural policy mainly concentrated on 2 objectives: developing cotton production to support state hard currency earnings through export and achieving self-sufficiency in grain production. In order to fulfil those goals the government has preferred to take a slow “step by step” path in reforming agriculture based upon restructuring of agricultural enterprises for producing those two “strategic crops”. Effect of different political and economical factors goes in the opposite direction, so the government by arrangement of land reform would like to solve many dilemmas: on one side to give social freedom in land and support the interests of different groups (collective enterprises, tenants, regional elite, households) and on another side to keep under controlling the production chain. The combination of factors such as state intervention of the input and output markets, misapplication of the bankruptcy law, counterproductive taxation, the lack of a land market, and an ineffective finance system, effect on the reform process and is hesitant conflicting going ahead. More than 20,000 farms had been established since 1998. They are completely free in their activities according to the law, but they are severely constrained in practice. The problems, however, are not only external, but also lie within the enterprises themselves.

The objective of this paper is to analyse efficiency of wheat producing farms, established on the land after restructuring of the collective farms using Data Envelopment Analysis. To identify the determinants of technical efficiency, a second stage analysis using Tobit regression was performed. As a case study one region of Uzbekistan was chosen for efficiency estimation. Efficiency analysis results reveal that farms vary to a great extent in on the levels of efficiency. The relative differences in economic performance reveal that the problems are not only external, but also lie within the enterprises themselves.

Keywords: Private farm, scale efficiency, technical efficiency, transition economy

Perspectives of Farmers and Experts Regarding Future Agricultural Development: Results from a Future Structured Mental Model Approach

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To secure agricultural food production, pesticide application is increasing and, despite extensive educational programs, farmers continue to take high health and environmental risk when applying pesticides. We assume that the success of educational interventions depends on three major points: **(a)** the capability to incorporate local knowledge and local development plans into regional and national agendas; **(b)** the ability to define sustainable agricultural development and to communicate this definition effectively; and **(c)** the coordination of governmental and nongovernmental interventions. In order to test our hypothesis our research goals are: **(a)** to analyse local knowledge by using the mental model approach and therefore to understand better farmers' perception of current and estimated risks' in a desired future; **(b)** to find a common definition of sustainability by comparing experts' future perspectives and their appraisal of farmers development potentials and **(c)** to coordinate different interventions by detecting crucial elements for the improvement of farmers livelihood. For achieving these goals we interviewed ten farmers concerning their future expectations and development plans. Subsequently ten experts were interviewed about the feasibility and the consequences of farmers' future perspectives. The interviews were posed open ended and structured in three parts: **(i)** future perspectives and ranking of future development options with respect to their importance for farmers' livelihood; **(ii)** analysis of the dynamic consequences of future developments within the system; **(iii)** importance and roles of agents in farmers' agent network for achieving the desired future. Following this structure, the interviews were analysed qualitatively and statistically for each part separately.

Our analyses show that the future perspectives and consequences expected by farmers differed from the expectations experts have. Furthermore, while farmers' future perspectives coincided widely among them, experts' opinions' deviated significantly within the experts group. Applying the structural mental model approach (SMMA) for the assessment of future perspectives, we were able to identify measures for improving the interventions for sustainable agriculture. One measure is the reduction of deviations in thinking between farmers and experts, which hinders the implementation of policies. Another measure is the coordination of existing interventions and capacity building of farmers with respect to a common goal.

Keywords: Sustainable agriculture, agricultural development, communication

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A Comparative Economic Analysis of Conservation Tillage and the Mouldboard Plough in Zimbabwe's Subsistence Farming Sector

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There is increasing concern about environmental degradation globally. In developing countries, the agricultural practices hitherto used by farmers are leading to accelerated soil erosion and land degradation. Resultantly, in fragile and low input agriculture systems like those in Sub-Sahara Africa crop yields show a decline trend, threatening the livelihoods of the majority of the population who are poor subsistent farmers. As an intervention, conservation tillage which ensures minimum disturbance of the soil is being encouraged to replace the erosive convention mouldboard plough in southern Africa. Besides reducing soil erosion, conservation tillage is claimed to reduce the drudgery associated with the mouldboard plough. Findings have shown that among many factors, financial returns is the most dominant factor farmers consider in abandoning their old practice for the new one. The main objective of this study was to evaluate the possibility of adoption of the environmentally beginning conservation tillage. The study compared financial profitability of conservation tillage relative to the conventional mouldboard plough in the production of the main staple crop, maize under typical subsistence farmer conditions in Zimbabwe. The standard enterprise gross margin analysis was used to show the relative financial profitability of the two technologies in terms of three indices: gross margin, returns to land and returns to labour. The study is based on one cropping season (2005/6) data from 8 on-farm trials located in two contrasting agroecological zones in Zimbabwe. Average labour use and maize grain yields were obtained from the on-farm trials, and prevailing local market prices were used for all inputs and outputs. In addition, sensitivity analysis was done to compare the risk profiles of the two technologies.

Keywords: Conservation tillage, subsistence farmer, Zimbabwe

Biophysical Factors Affecting Maize Productivity of Small-Scale Farming System under Three Settlement Schemes in North-East Zimbabwe

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After Zimbabwe's independence in 1980, the land owned by white farmers was soon started to be seized by the rural population. In 1997, a land reform was instituted, and nowadays most of the "white" farm land is redistributed and parcelled into many small-holder farms. However, due to continuous crop cultivation without adequate fertilisation and limited soil conservation, crop yields abruptly declined in Zimbabwe, leading to reduced food security at national level. The objective of the present study was to identify which factors are limiting maize productivity at village level along three farming settlement schemes, i.e. communal area, old and new settlement areas, in North-East Zimbabwe. The study focused on maize, the main staple crop in the region, and further consisted of two main phases: (i) Land use characterisation and soil assessment in cropping fields from three villages and, (ii) Detailed maize performance assessment, together with a survey regarding crop management and input use.

In the first phase, transect walks were carried out to map the cropping fields in each village. Once cropping fields were mapped by using GPS and ArcView, a nested non-align block design was used to select a representative number of sampling units in each village. The selected sampling units were characterized using the FAO Land Cover Classification System. The purpose of this phase was to understand the maize pattern distribution within the cropping fields and identify the main biophysical characteristics. In the second phase, twenty seven farmers were selected to conduct a detailed study of the farm household and management with emphasis on maize productivity. For each village nine farmers, three from each wealth class (rich, medium and low) were randomly selected. The data collection was sub-divided in two phases: (i) data information of farm household characteristics and crop management and (ii) soil and crop sampling on their plots. Data retrieved during this phase was evaluated by a Multiple Regression, Principal Component, Cluster and Factor Analysis. Data analyses identified main factors by village and wealth classes influencing maize performance. The study aimed to provide a basis to develop a methodological tool to assess and improve land quality of the newly established smallholder farms in Zimbabwe, in the future.

Keywords: Food security, settlement schemes, maize performance, Zimbabwe

Perceptions and Potential of Resource Conserving Technologies in the Crop-Livestock Systems of the Indo-Gangetic Plains

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The impressive agricultural growth rates of previous decades in the intensive irrigated rice-wheat-livestock systems of the Indo-Gangetic plains in South Asia have declined considerably over the past years. This contributes to the difficulties facing rural poor attempting to participate in the general economic upswing currently evident in most countries of the region.

The Rice-Wheat Consortium, an eco-regional collaboration between CGIAR centres and national research institutions, has identified intensive tillage practices and prevailing crop residue management as causes for widespread soil degradation, a fundamental cause of stagnating crop yields. Reduced or zero-tillage systems in combination with the retention of crop residues as mulch are recommended as efficient measures for maintaining and improving soil fertility. However, crop residues, in particular rice and wheat straw, are an important feed resource within the mixed farming systems predominant in the region, livestock being especially important for poor households. The current research project aims at quantifying drivers and constraints associated with the use of zero-till seeders and improved crop residue management at nine study sites from the Indian Punjab to Bangladesh. Household effects of introducing the recommended technologies will be estimated by household models taking into account the considerable interactions between crops and livestock.

At this stage of the ongoing study, the adoption and perceptions of various technologies with an impact on soil fertility and crop residue management (e.g. irrigation, tractor tillage, combine harvester, zero-tillage) are analysed on a village level for the selected study sites. The wide variation between sites in regard to important characteristics, such as climate, resource endowments, cropping patterns, livestock feeding regimes, price structures and market integration, enables a detailed investigation into the impact of these characteristics on current technology adoption. On this basis the potential of increased adoption of resource conserving technologies in the less developed eastern region and of intensifying integrated livestock production is assessed. For poor households with limited land resources the latter strategy could be especially promising.

Keywords: Bangladesh, crop residue management, crop-livestock interactions, India, resource conserving technologies

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Improvement of Food Security and Income through Utilisation of Marshlands in the Province of Gitarama (Rwanda)

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Land scarcity due to intense population growth, high population density as well as to the consequences of a subsistence economy with extensive production levels has forced the Rwandan government to cultivate its remaining land resources, the marshlands that comprise ca. 12 % of the utilised agricultural area (UAA). In addition to goals of assuring food security the exploitation of marginal, erosion-threatened hill-sides should be prevented. While Kenya, Tanzania and others want to follow the Rwandan example the social situation of small scaled farmers in the Rwandan wetlands after implementation of the governmental programme is unclear. No social-economic studies have been carried out on the improvement of the situation of life and the frame conditions of farm management neither for the local, nor for the resettled farmers.

The goal of this study is to analyse the political, administrative and social implementation of the marshland use programme in regard to the improvement of food security, social services and income development of small scaled farmers in the research areas. The research concept builds on the model of implementation theory with the programme characteristics (programme goals and measures, target group selection), actors and agencies involved in implementing the programme (quantity and quality of staff and funds, own targets and action constraints) and programme addressees (acceptance of the program, socio-economic status quo) as the central factors of influence. Structured interviews, group discussions and guided expert interviews in the marsh districts Rugeramigozi and Base were conducted. The period of food security, the possibilities to sell to markets and the monthly household income have increased as a result of the cultivation of marshlands. A high motivation with regard to those actors and agencies involved in implementing the programme and an improvement of the social situation of the addressees is noticed. However, the lack of follow-up financing, inadequate legal regulations, inadequate information for the farmers regarding land use as well as the nearly unchanged, deficient social infrastructure threaten the sustainable development of the achieved results. Concrete measures to improve rural networks and social infrastructure are recommended for the future governmental action.

Keywords: Implementation, income improvement, food security, marshlands, wetlands, Rwanda

A Comparative Analysis of Land Use Systems in Benin

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Last year, a small farmer survey was carried out in Benin for deep understanding of the land use system in twelve villages. These villages were chosen in different districts according to specific criteria (Banikoara, Bassila, Dangbo, Djougou, Kétou, Klouékanmè, Matréri, Nikki, Ouessè, Parakou, Toffo, Zagnanado). A questioner was administrated to twenty farmers in each village. Different data related to the land use system were collected: composition of land, land prices, land use changes, cropping system, labour force, income and food security strategies. The aim of this paper is to give a global view of the land use systems in the study area. More specifically, we will discuss in a comparative basis:

- The composition of land use and land price in each region;
- The yield of the major food crops and its development during the last years;
- The relationship between the yield and other variables such as fallow period.
- The yield development after fallow;
- The farmer's food production strategy ;
- The importance of price in farmer's production strategy.

The data were processed by means of descriptive statistic tools.

The results show that:

- The role of fallow period on the yield development vary from region to region and inside the same region from crop to crop.
- Prices (buying or selling price) play a major role in the farmer's production strategy. However, the farmer's decision to produced specific food crop depend on its role in the household food supply strategy.
- The study shows that cotton production decreased in many regions due to marketing related problems.

Keywords: Fallow, food crops, land use changes, Benin

Towards the millennium development goals: Innovation and adoption in agriculture and forestry

a)	Agricultural marketing and rural institutions	125
b)	Food security and food safety	145
c)	Determinants of technology adoption and implications for policy and program design	177
d)	Sustainable development in practice - examples from GTZ's projects	191
e)	Research for development practitioners	197

Agricultural marketing and rural institutions

Oral Presentations	127
LISA AIGELSPERGER, MICHAEL HAUSER, JEMIMAH NJUKI: Commercialising Organic Agriculture. Does it Improve Household Food Security? A Case Study from South-Western Uganda	127
REINHILD BODE, JÜRGEN PIECHACZEK: Innovations Towards Product Differentiation - Farmers Organisations' Strategies to Integrate into Specialty Coffee Value Chains	128
JASON DONOVAN, DIETMAR STOIAN, NIGEL POOLE: Development of Rural Community Enterprises for Poverty Reduction: A Global Review of Critical Success Factors	130
SIRAK BAHTA, SIEGFRIED BAUER: Analysis of the Determinants of Market Participation within the South African Small-Scale Livestock Sector	131
Posters	132
MARIA MIGUEL RIBEIRO, MICHAEL HAUSER: Using Multi-stakeholder Processes to Improve a Supply Chain of a Non-timber Forest Product in Lao PDR	132
ULRIKE MÜLLER, ALEXANDER HOBINKA, CHRISTIAN BERG, SUSANNE BERCHER-HISS, MARTINA FELL, SIDDHARTH PRAKASH: Linking the Poor to Domestic and Export Markets: An Analysis of Agricultural Value Chains in Sub-Saharan Africa, Ghana	133
BAROMEY NETH, BÉATRICE KNERR, SAM OL RITH: Using Ecotourism as a Rural Development Tool in Cambodian Protected Areas: Analysis of State and Global Politics	134
TANTY S. THAMRIN: Land Use Diversification as a Strategy to Cope with Long Drought Periods: A Case Study from Nusa Tenggara Timur (NTT), Indonesia	135
AZADEH SALEHI, MASOUD TABARI, JAHANGARAD MOHAMMADI: Accumulation of Fe, Mn, Cr, Pb and Ni in Soil and Leaf of <i>Pinus eldarica</i> Medw. Trees Following Irrigation with Municipal Effluent in Iran	136

IVONE GORETE LUCENA FRIEDERICH, RALF NOLTEN: Land Use Conflict or Cooperation: Challenges in the Management of the Serra Dos Orgaos National Park, Brazil	137
KHIN MAR CHO, JOHN NETTLETON: Sustainable Agricultural Marketing Development through Empire State Marketmaker	138
NORMA ELY SANTOS: Co-ops and the Climate Change Mitigation Activities: Handling with Low Carbon Businesses in the Rural Sector.	140
NORMA ELY SANTOS: Rural Employment Creation in Africa: A Review of the Main Strategies and Policies	141
HOSSEIN MAHMOUDI, HOUMAN LIAGHATI, MAJID ZOHARI: The Role of Organic Agriculture in Achieving the Millennium Development Goals: Challenges and Prospects in Iran	142
FRANKLIN SIMTOWE: Who is Credit Constrained? Evidence from Rural Malawi	143
BOHUMIL HAVRLAND, PETRA HOLIKOVA: Promotion of Agricultural Education at State Agrarian University of Moldova as a Tool for Agricultural Development	144

Commercialising Organic Agriculture. Does it Improve Household Food Security? A Case Study from South-Western Uganda

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The debate about the impact of commercial organic agriculture on food security in developing countries is controversial. While some authors argue that the premium price allows farmers to purchase food, other authors are of the opinion that commercialisation is at the cost of household food security. Sufficient empirical evidence that supports these propositions, however, is missing. This research addresses the lack of information in this area and was aimed at understanding how commercial organic agriculture influences food security at household level, whereas special emphasis was put on farmers' perceptions of changing food security.

Based on the sustainable livelihoods approach, the study operationalised the term food security by distinguishing three essential dimensions: availability of food, access to food and utilisation of food. An ex post evaluation following the conversion to organic agriculture was carried out in Rakai/Masaka district, south-western Uganda. The sample included certified and non-certified organic households which were contrasted with households carrying out traditional agriculture in neighbouring villages. Data were collected using structured household surveys in combination with PRA. Both qualitative and quantitative data were generated.

The results of the study reveal that organic agriculture interventions positively address several household food security dimensions, hence supporting farmers to improve their livelihoods. Higher income through premium prices, enhanced knowledge on natural resource management and higher diversity of crop and livestock production of organic farmers were identified as the main entry points for improved household food security. However, there are gaps in the household food security equation, notably because improved access and availability of food does not always translate into proper utilisation of food.

The results of this study suggest that more emphasis should be placed on the knowledge dimensions through holistic training guidelines for organic farmers. These guidelines shall integrate nutritional education with other important livelihood strategies for improving dietary diversity as cross-cutting themes.

Keywords: Commercialisation, household food security, organic agriculture, Uganda

Innovations Towards Product Differentiation - Farmers Organisations' Strategies to Integrate into Specialty Coffee Value Chains

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Volatility of liberalised commodity markets causes insecurity of livelihoods of those millions, who are living in rural areas and depending on agriculture. Differentiation of products, by improved and specialised qualities, certification of compliance with environmental and social standards as well as determination of origin is one strategy to break out of ever declining commodity prices.

This is the case for coffee, the second most valuable legally traded commodity in the world after petroleum, heavily affected by repeated price slumps, driving 25 million coffee growers on the edge of poverty. Differentiation takes place since the development of the specialty coffee industry, demanding high organoleptic quality to be distinguished by good taste and a unique origin. Different certification schemes provide another way towards differentiation, although with almost less demanding cup quality requirements.

However, the change from a volume oriented production model towards a model, which rewards high organoleptic quality by higher prices needs significant changes and innovations. This paper is based on 4 case studies of Colombian and Ecuadorian coffee growers' organisations which are on their way of getting or maintaining their position within specialty coffee value chains. Their significant changes in order to improve quality and access to specialty coffee markets have been analyzed. This paper argues, that **(1)** socio-organisational changes and the development of business skills, rather than technical improvements, are the more demanding innovations. **(2)** Access to and the understanding of quality and price related information, as well as good management of up- and downstream relations are key for the organisations' leaders.

It finally assesses the impacts of innovations through product differentiation, comparing high quality, certified and conventional coffee. **(3)** Certification schemes may provide a step towards differentiation, however they don't necessarily guarantee sustainable prices. High quality may offer prices at relatively high level, but require very demanding business skills, which are generally absent at farmers' level.

Stronger commitment and support of the individual initiatives of farmers' organisations by national coffee growers' associations could contribute to scale up the innovation process. In order for this to happen, broader and lengthy changes at institutional and political level are required.

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Keywords: Innovation, product differentiation, socio-economic impact, specialty coffee, value chains

Development of Rural Community Enterprises for Poverty Reduction: A Global Review of Critical Success Factors

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Rural community enterprises (RCEs) are unique in their institutional arrangements for the production and marketing of agricultural and forest-based products. They are owned by groups of smallholders ranging from a few dozen to several thousands and typically pursue multiple objectives, with profit maximisation as only one of many goals. Other goals may be equally, if not more important, including community development, improved local safety nets, and increased influence over political processes. Access to productive resources may be collective or private, and enterprise governance is influenced strongly by local rules, practices, and customs. The development of RCEs can contribute to the Millennium Development Goals #1 (“Eradicate extreme poverty and hunger”), #3 (“Promote gender equality & empower women”), and #7 (“Ensure environmental sustainability”). However, many RCEs in the initial phases of enterprise development tend to exhibit low levels of output, productivity and profit, resulting in weak bargaining power along value chains. Government and NGOs can play an important role in the development of viable RCEs, but their impacts to date have been limited, due partly to their production-oriented approaches to rural development. In addition, the political-legal framework in which RCEs operate, including policies, laws and institutional arrangements related to business organisation, land tenure, and taxes, has not favoured their development, resulting in high transaction costs and an uncertain investment climate. This paper addresses the potential of RCEs to reduce poverty and promote gender equity without compromising the natural resource base. We present the results of a global review of RCE development, based on 25 case studies from 12 countries in Latin America, Asia, and Africa. These studies cover a wide range of productive activities and services, including the extraction and transformation of timber and non-timber forest products, production and processing of agricultural products, such as coffee, cacao, vegetables, and banana, as well as ecotourism. We identify critical success factors for the development of environmentally friendly RCEs and determine their impact on the generation of employment and income for both males and females. We conclude with institutional and policy options for promoting enabling environments for RCE development.

Keywords: Critical success factors, global review, Millennium Development Goals, rural community enterprises, value chain integration

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Analysis of the Determinants of Market Participation within the South African Small-Scale Livestock Sector

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The livestock sector plays a crucial role in the household food security and poverty alleviation of many developing countries by producing protein-rich food supplies, generating income and employment. It is identified, in the Integrated Sustainable Rural Development Strategy, as a most likely agricultural enterprise to improve the livelihood of small scale livestock farmers in South Africa. However, not much has changed as far as livestock marketing is concerned. This situation requires an in depth investigation.

The main interest of the study is not on the quantity of livestock sold by the farmers, but the probability of a positive event occurring. That is, to investigate the major factors which determine livestock farmers' decision to participate in the market. A binary logistic regression is applied on primary data that was collected from 104 households in all five districts of Free State province, namely: Motheo, Lejweleputswa, Thabomofutsanyana, Xhariep and Northern Free State. Market information, births, distance to the preferred marketing channel and training were identified as both logical and statistically significant determinants of farmers' decision to sell their livestock. This entails that policy interventions in direction of these factors need to get priority attention by stakeholders, especially as far as the formulation of institutional innovations are concerned.

Moreover, this paper offers quantitative guidelines on the issues to focus on when addressing apparent institutional constraints that are currently inhibiting the ability of small-scale livestock farmers to access livestock markets in South Africa.

Keywords: Livestock, market participation, South Africa

Using Multi-stakeholder Processes to Improve a Supply Chain of a Non-timber Forest Product in Lao PDR

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Non-timber forest products (NTFP) are known as important source of cash for many of the world poorest, including for the upland dwellers of the Lao PDR. The Lao PDR government advocates a market-led development strategy as a way to eradicate extreme poverty and hunger. Nevertheless, the promotion of market involvement is a challenging task as it depends on the effectiveness of collaborative arrangements of all stakeholders involved in its commercialisation.

In order to improve the chances of market integration of paper mulberry bark, a promising NTFP, a multi-stakeholder process was settled to enhance action between chain stakeholders. The process started with a participatory analysis of the Lao paper mulberry supply-chain. This process allowed interaction between different functions of the supply-chain (e.g. producers, district traders, exporters, manufacturers, consultants, government extension). Multi-stakeholder workshops offer a platform for social learning, in which the stakeholders of the supply-chain can innovate and adapt their strategies in response to changing social and environmental conditions that are affecting the supply-chain. Increased discussion about the necessary changes to improve the supply-chain allowed participants to decide what type of interventions should be done, so that these interventions could fit their needs, responsibilities, benefits and thus, enhance their ownership over the project and assure the implementation of action-plans.

Most of the planned activities were related to production issues: increase the planted area, improve quality of the bark, form a village marketing group and promote contracts. In addition, individual causal maps made to individual farmers, at that time, show that they perceived individual benefits from pursuing the agreed action-plan. Nevertheless, one year after the process started, results show that some of the agreed actions were not implemented by stakeholders and that increased income and stable prices were not achieved equally throughout the supply-chain. It is argued that even though stakeholders are aware of the benefits of implementing the action-plan, there are capacities and structures that impede them to change the status quo of the supply-chain. This paper discusses the influence of these constraining factors on development interventions in the Lao context.

Keywords: Lao PDR, multi-stakeholder process, NTFP, participatory supply chain analysis, rural development, social learning

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Linking the Poor to Domestic and Export Markets: An Analysis of Agricultural Value Chains in Sub-Saharan Africa, Ghana

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In the last few years, great importance has been attached to agricultural value chain promotion in order to contribute to the achievement of the Millennium Development Goals. The question of how to link the poor to local and international markets is controversially discussed in the current debate on pro-poor growth.

This study investigates into selected value chains of mango, cassava and grasscutter (*Thyronomys swinderianus*) in Ghana. Agricultural production in Ghana is characterised by small-scale farming and processing. Does adding value to export and domestic commodities generate profits and employment for the poor along the value chains under review, thus making a contribution to pro-poor growth? The following hypotheses are assessed: a) processing for domestic markets generates more employment and value than the export of fresh commodities; b) price levels of domestic and export markets do not clearly favour supply for the latter; c) increasing market orientation and commercialisation improves social and food security of poor men and women, who make up for 40% of the population.

The value chain analysis of the three commodities shows that their competitiveness is limited by various inefficiencies which particularly affect the resource-poor. Governance is a crucial factor that determines the organisational degree of value chain operators and their ability to generate profits. In addition, the resource-poor face several entry barriers such as regular supply to the market, high investment and production costs as well as standards for export markets. Therefore, price levels on international markets do not justify a sole focus on export promotion, especially if costs of market entry for the resource-poor are taken into account. Poverty-oriented potentials of linking small-scale producers and processors to domestic markets are under-utilised in Ghana.

Policy recommendations derived by the study suggest that development agencies should specify pro-poor value chain promotional approaches in terms of target groups and the expected poverty impact on these groups. Without fostering necessary physical and institutional infrastructure as well as human capacities at the micro level, value chain promotion activities in development cooperation are likely not only to by-pass the poor but to widen the gap between the poor and non-poor.

Keywords: Agribusiness, Millennium Development Goals (MDG), pro-poor growth, rural development, value chains

Using Ecotourism as a Rural Development Tool in Cambodian Protected Areas: Analysis of State and Global Politics

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Many studies have focused on the positive impacts of ecotourism, resembling a proper innovation in rural development. Being an alternative approach, ecotourism is perceived to have positively changed local livelihoods and environmental conservation. Its benefits to rural protected areas lie with increased local ownership and participation, economic growth and diversification, job creation and variation, decreased mobility of locals, improved infrastructure and social services, cultural revitalisation, increased social capital, etc. However, little attention has been given to the interplay of state and global politics in manipulating strategic planning and management of rural protected areas. This question concerns whether management structures and principles of ecotourism should be central and intimidating or be participatory, cohesive and coherent. Failing to consider different micro and macro politics of actors and beneficiaries within rural development practice could lead to paradoxical or ambiguous development of ecotourism across multi-sectoral interests.

This article examines the politics of ecotourism from different viewpoints of actors and benefit recipients, which influence decision and policy making and planning of community-based economic development and conservation through ecotourism initiatives in rural areas. It presents a wide range of debates on environmental governance and poverty alleviation in poor but natural resources rich areas of Cambodia after having been incorporated into global networks. By using data from different case studies, especially on community-based ecotourism (CBET) at a Chambok site and an ecotourism project in Boeung Tonle Chhmar (BTC) core area, this study provides a good example of North-South relations. Moreover, it identifies structural change due to neoliberalism, global environmental governance, access to common property resources, development focus, interest conflicts, dichotomy of ecotourism and policy framework for ecotourism development in rural protected areas.

Keywords: Common property resources, global environmental governance, neoliberalism, north-south relation, ecotourism, Cambodia

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Land Use Diversification as a Strategy to Cope with Long Drought Periods: A Case Study from Nusa Tenggara Timur (NTT), Indonesia

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Changes in weather conditions due to global warming have an influence on agricultural production. Long drought periods caused by El Nino directly influenced food supply in Nusa Tenggara Timur (NTT) province, Indonesia during the last years. The paper is based on data collected through mass-media, discussion and interviews with local authorities, communities, non governmental organizations, community based organizations, research centers, and local news-papers in NTT.

From the end of 2006 to the beginning of 2007, 16 districts in the province faced longer dry-seasons than usually. This caused planting and harvest failures especially for the dry-land commodities. The provincial office for food security expected a food crisis at community level as a result of the long-dry seasons. The NTT's coordination and implementation committee of disaster predicted that a total of 116,634 households or about 467,673 people would be affected. In February 2007 food stocks available at governmental and community levels was sufficient only to cover the community's need for food for the next 1.5 month up to April 2007. The office predicted that the farmer's total harvest production could cover their needs for the next four months until June 2007. This means that even if the next rainy season comes on time there will still be several months of food deficit before the next planting season in November 2007 to February 2008. Therefore the local government suggested to the farmers to plant various beans (green beans and soybeans) or tuber (cassava) towards the end of the rainy season. Farmers of several communities in NTT have developed land-use diversification strategies to cope with the long drought periods.

The land-use diversification strategies developed by the local communities can be effective in coping with food deficit after long drought periods.

Keywords: Community, food deficit, land use diversification strategy, long drought, Indonesia

Accumulation of Fe, Mn, Cr, Pb and Ni in Soil and Leaf of *Pinus eldarica* Medw. Trees Following Irrigation with Municipal Effluent in Iran

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As a whole, water is counted the most vital source for afforestation especially in the dry zones. On one side, it is viewed that municipal effluent can be used to cover the needs of city and jungle parks on its vicinity as well as industrial complexes in order to develop green space and decrease air pollution. In reality, municipal effluent other than safeguarding water for the plantations and also saving the water resources is counted as an overflowing source of nutrient element. Apart from this, in the case of the utilisation of effluent mixed with harmful heavy metals lead to decrease the toxicity, through a developed rooting system (acquired from afforestation) and as such, play important and fundamental role for the environmental protection. However, this also can not be ignored that the use of effluent for irrigation purpose might strike ecosystem. Therefore, decision about the application of effluent should be decided based on specialties of water, soil, plant and environment of every location In this study, the accumulation of heavy metals was studied in samples of soil and leaf of *Pinus eldarica* Medw. trees in two afforestation irrigated by municipal effluent and well water in south of Tehran. For this purpose, four sample plots (30 m×30 m) were randomly chosen in either of both areas. In each plot, samples of leaf and soil (0–15, 15–30, 30–60 depths) were taken in four replications. Concentration of Fe, Mn, Cr, Pb and Ni in samples of soil and leaf were determined in laboratory. The results revealed that the concentration of Fe and Mn in leaf of *Pinus eldarica* Medw. trees and Concentrations of Fe, Mn, Cr, Pb and Ni in soil were significantly greater in area irrigated with municipal effluent than in well water. The results do not show any Cr, Pb and Ni in samples leaf.

Keywords: Heavy metals, irrigation, municipal effluent, *Pinus eldarica*, soil pollution, Iran

Land Use Conflict or Cooperation: Challenges in the Management of the Serra Dos Orgaos National Park, Brazil

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In many developing countries inconsistent policies often contradict conservation and development goals and affect the ways actors use and manage natural resources, creating, as a result, conflicting land use systems. In order to conserve the environment, the primary instrument has been to keep the population out by a zoning policy, creating protected areas by a law without consultation of local stakeholders. In the Brazilian Atlantic Forest of Rio de Janeiro, apart from problems related to land tenure insecurity, natural resources and biodiversity conservation are threatened by the conflicts of interests between the conservation of the biodiversity and the development of diverse land uses of surrounding communities such as illegal settlements, intensive use of agrochemicals, hunting and fire for land clearing.

Recognizing that the effective management of resources cannot mean only “zoning the forest” and that the effective participation of local stakeholders and institutional partnerships in the decision making process are a precondition to protect the nature and to improve livelihoods systems, this project aims to analyse the social dimension of ecosystem management. Based on the collective action and the “Institutional Analysis and Development” approach, it is this research’s objective to answer how institutional actors and the land tenure regime affect the way different actors use and manage the natural resources and which factors promote or constrain the alternatives of land use surrounding the protected areas.

By understanding these factors, this research will help to inform policymakers about ways to improve a management plan which achieves, at the same time, the preservation of natural resources and the protection of economically vulnerable groups.

For the empirical study several data collection techniques will be applied, such as narrative expert interviews, focus group discussions with representatives of institutions, questionnaire-supported household’s surveys and in-depth interviews with members of local communities.

Keywords: Atlantic forest, collective action, natural resources management, South-east Brazil, stakeholder analysis

Sustainable Agricultural Marketing Development through Empire State Marketmaker

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The partnership of land grants and state agricultural agencies is building a national network of interconnected MarketMaker sites, with 17 States expressing formal support and commitment to generate local resources for the project. Each partner state will have its own unique site, but all sites access a common database, allowing users to query all states in the system. The University of Illinois Extension was the first online. The network has one of the most extensive collections of searchable food industry related data in the United States with over 65,000 profiles of farmers and food related enterprises in Illinois, Iowa, and Nebraska. Kentucky's MarketMaker went live in early 2007 and New York is being brought online now (<http://nymarketmaker.cornell.edu>). The main features of MarketMaker include:

- [1] Customized Market Profile - users can build a personal trade area with target census tracts, summing up queries and demographic data to map and print;
- [2] Consumption Pattern Data- a new feature allows users to map the highest concentrations of consumer by product;
- [3] Buyers and Sellers Forum- businesses can make weekly posts of available or needed food products, paving the way for potential business relationships.

The researcher collected the basic producers information from different agricultural organizations such as Pride of New York, Northeast Organic Farming Association, South Central New York Agriculture Program, Finger lakes Culinary Bounty, New York Wine and Grape Foundation, New York Apple Association, and New York State Vegetable Growers Association. In addition, data on farmers markets, state and federally inspected processors were gathered. To get the detail information on current business, the researcher sent structured registration forms to producers and processors by mail and email. They were asked to complete registration forms and return to the researcher. The registration form includes business name and address, contact person, website and email address, telephone and fax numbers, product type, product attribute, product form, product sales, farm operating hours, and additional business information. Producers and processors were asked by telephone for the required additional information.

The New York MarketMaker site has an initial database of over 2,000 Empire State producers. It equals the existing four States Market Maker network. We collected and organized all producer information through early April 2007. The New York

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MarketMaker site went live in early July 2007. Every farmers or business registered on New York MarketMaker (Empire State Market Maker) can edit and update their own online profiles via a secure password. New York will design and develop its own educational outreach geared to food retail, trade and industry groups to better assist Empire State producers and their associations and teach food entrepreneurs how to use the New York State website. We hope producers, processors, food retailers, consumers, food supply chain actors, and farm business are now taking advantages of of access to trade, marketing and food industry resources that can be motivated to buy directfrom Empire State Producers. We are planning to carry out the further research on impact assessment of New York MarketMaker, perceptions of producers and processors on their economic development via MarketMaker.

Keywords: Agricultural marketing, New York MarketMaker, United States

Co-ops and the Climate Change Mitigation Activities: Handling with Low Carbon Businesses in the Rural Sector.

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The current situation regarding to climate change has aroused concern worldwide and brought in a broad range of potential mitigation and adaptation activities with local, national and global benefits. Such activities have been developed through the efforts of many organisations, governments and enterprises, and range from the development of lower-emission technologies to better land-use practices in agriculture and forest lands. Given that carbon emissions reductions also deliver a range of benefits, including short and long-term business opportunities as well as increased awareness of social and environmental responsibility, many producers and consumers associations have organised their members toward low carbon businesses.

Guided by the principle of concern for the community, co-operatives may have a comparative advantage to adopt measures in order to contribute to the reduction of atmospheric GHGs. Thus, co-operative associations in rural areas with their basic values of self-help, self-responsibility, democracy and solidarity, have launched some initiatives to offset carbon emissions including adopting renewable sources of energy provided by wind and solar technologies, planting biofuel crops and implementing land-use and forestry based carbon sequestration projects through crops, forest and grassland management. By engaging in the emerging low carbon businesses, co-operative associations in rural areas worldwide can obtain benefits for themselves while contributing to achieve global targets. Therefore, the purpose of this paper is to describe the social and economic context that has motivated co-operatives enterprises to tackle climate change mitigation in rural areas and to identify the portfolio of activities that have been developed so far, with emphasis to the social and environmental benefits achieved.

Keywords: Climate change, co-operative associations, rural areas, carbon business

Rural Employment Creation in Africa: A Review of the Main Strategies and Policies

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Given that the rise of unemployment poses a serious threat to the poor people livelihoods and became a pressing problem in African countries, considerable attention has been focused on rural sector in Africa with regarding to its potential to employment creation. Rural sector in Africa, including farm and non-farm activities, is the source of inputs to processing, manufacturing and retail businesses that account for most employment in towns. Evidences from studies have confirmed that employment creation is the most efficient mean to fight against poverty and for this reason it must be included in the overall macro-economic policies in Africa. With this context in mind, this paper develops an overview of selected strategies, programmes and policies that have been applied to promote and consolidate rural employment in Africa, showing the features of the local socio-economic context. A comparative assessment is performed on the main elements and patterns present in the successful experiences, allowing for conclusions to be drawn on the level of future implementations in regions with similar conditions. Based on the literature survey along with case studies, the paper also provides an examination of current constraints and perspectives, and the role of governmental and non-governmental organisations to enhance the employment generation strategies for rural Africa. The paper ends by pointing out the principal findings from the literature survey on the rural employment generation and the linkages with other determinants such as international agricultural markets, credit and investment, labour earnings, land conflicts and appropriate technical training to perform rural activities.

Keywords: Policy, rural employment, rural sector in Africa

The Role of Organic Agriculture in Achieving the Millennium Development Goals: Challenges and Prospects in Iran

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Organic farming is nowadays considered as an alternative farming approach. Despite organic farming is the oldest form of agriculture on earth; few attentions have been paid to develop this approach. In fact, while organic farming has promoted as environmentally-friendly approach and developed during the last few years in most developed countries, there are few emphasising on developing countries such as Iran. The debate has been especially motivated when organic farming has introduced as a holistic approach. The MDGs is a set of eight goals derived from the various declarations and commitments adopted in conferences organised by the United Nations. The MDGs cover a diverse set of development outcomes, ranging from halving extreme poverty to protecting the environment and promoting a global partnership in development. Each goal has corresponding time-bound targets, most of which should be achieved by 2015. Organic agriculture plays an important role in achieving MDGs, its impact is very greater when considered holistically due to the interrelationships among the MDGs. Organic agriculture can with impacts such as stable income, better nourished and healthier children are more likely to stay in school, healthier women from more nutritious farm products, less exposure to pesticides, conservation of water, water resources and soil help in achieving the MDGs. In other words, organic agriculture has the potential to address multiple MDG targets. On the other hand, this provides a case for government in developing countries such as Iran to look more seriously into supporting organic agriculture. This paper will briefly review the scope of the MDGs and the role of organic agriculture in achieving them.

Keywords: Iran, Millennium Development Goals, organic farming

Who is Credit Constrained? Evidence from Rural Malawi

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The limited nature of poverty assistance funds for credit implies that only a few can benefit from such funds at a time. Considering the complexity of designing credit contracts with incentives that are constraint compatible, microfinance institutions are continuously exploring strategies for identifying and targeting credit constrained households as a way of improving efficiency in the delivery of financial services. The objective of this paper is to examine factors that influence a household's likelihood of facing credit constraints in Malawi. The data used in the study was collected in Malawi by the International Food Policy Research Institute (IFPRI) in collaboration with the Rural Development Department (RDD) of Bunda College of Agriculture. The survey was conducted in three rounds and covered 404 households in the three regions of Malawi. This paper, however, uses data from the first round only. The households credit constraint status was established by using the direct elicitation approach. The analysis on determinants of credit constraints was done using probit. The study reveals that characteristics of a household head as well as the supply side factors such as the remoteness of the location in which the household is based, significantly increase the likelihood that a household will face credit constraints. Participants in credit programs are less likely to report credit constraints, an indication that barriers to participation in credit markets continue to exist. Results suggest an urgent need for formal financial institutions to expand their outreach in order to address the huge and ever growing unmet demand for financial services among rural peasants and women in particular.

Keywords: Elicitation approach, credit constraints, Malawi, poverty assistance

Promotion of Agricultural Education at State Agrarian University of Moldova as a Tool for Agricultural Development

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The dominant sector of the Moldavian national economy is agriculture and food industry since it accounts for 33 % of GDP and 65 % of the country's exports. That is due to the limitation of other natural resources, especially energy, temperate climate and fertile soils. On the other hand, Moldavia produces practically no mineral fertilisers, pesticides, mineral or vitamin additives for food or feedstuffs, veterinary medicines or fuel. Importing these items raises prices for the production sector including agriculture and food industry. Qualitative changes through improvements in the agricultural education are one of possible ways for the development of the country. This can be considered as a very significant contribution to meeting millennium goals through innovation in agriculture.

The State Agrarian University of Moldova (SAUM) is one of the prestigious universities in the country, but due to its past it features many shortcomings in its education programme structure, international cooperation, technical background and teaching aids, however its main constraints are the university staff age structure and qualifications.

The Czech University of Life Sciences in Prague (CULS) has been implementing a project at the SAUM which focuses on the above constraints and tends to assist the university management, through the know-how transfer and material grants. The main development objective is to support development of Moldavian higher education and rural development through increasing competitiveness of Moldavian agriculture, which is the basis of support for commencing access with the European Union. The specific objectives includes activities as reorganisation of study according to the Bologna declaration, implementing new environmental programmes, reviewing current study subjects and their syllabi, implementing and controlling utilisation of the credit system ECTS, organisation of courses for increasing the qualification of teachers of the University by improving their pedagogical and research activities and supporting their involvement in agricultural extension, organising consultant services in a specific area and improving laboratory equipment for research of alternative energies produced in agriculture.

The significant results were already achieved by the project which evidence importance of the inter-university trans-border cooperation and need of a scientific approach to the study programme formulation based upon the Bologna declaration implementation.

Keywords: Agricultural development, higher education, Moldova

Food security and food safety

Oral Presentations	148
MARC ZOSS, STEFAN PLETZIGER: Linking African vegetable smallholders to high value markets: Potentials and constraints in smallholders integration into EurepGAP-certified and/or domestic African high-value supply-chains	148
JOFI PUSPA, RAINER KÜHL: Food Quality, Safety Measurement and Control: The Future Challenge for Indonesia	150
EZEKIEL TEJUMOLA OTUNOLA, ELIZABETH OLUWASEUN SUNNY-ROBERTS, ADERONKE OLUWATOYIN SOLADEMI: Influence of the Addition of Okra Seed Flour on the Properties of ‘Ogi’, a Nigerian Fermented Maize Food	151
LU CHEN, JÜRGEN POHLAN, LI JIHONG, MARC J. J. JANSSENS: Comparison in Cup Quality of Arabica Coffee from Yunnan, China	152
Posters	153
SANTOSH SATYA, GEETANJALI KAUSHIK, SATYANARAYAN NAIK, ANUSHREE MALIK: Enhancing Food Quality and Safety in a Rural Habitat — A Holistic Perspective	153
ELISANGELA DE ALBUQUERQUE SOBREIRA LAGE, ALCIDO ELENOR WANDER, ALBENONES JOSÉ DE MESQUITA, MOACIR EVANDRO LAGE: Socioeconomic Impacts of Adulteration in Goat Cheese Production to Public Health in Brazil	154
OLUBUNMI AYOBAMI DUDUYEMI, GALMAN OMITOGUN: Assessing the Impacts of Agricultural Biotechnologies in the Tropics	155
MUNA ALI ABDALLA, ABDELGADER H. KHATAB, ABDUL-LAHI H. EL TINAY: Evaluation of the Nutritional Status of Children under Age of Five in Relation to their Feeding Patterns: Case Study-El Fau Rural Area, Sudan	156

- JOERG SCHUMACHER, EVA SCHLECHT, ANDREAS BUERKERT, OLIVER HENSEL:
Assessment of Meat Production and Meat Processing in Niamey/Niger: Hygienic Quality of Fresh Meat and of the Dry Meat Product “Kilishi” 157
- ELIZABETH OLUWASEUN SUNNY-ROBERTS:
An Evaluation of the Nutritional and Physicochemical Properties of Candies from Imitation Milks 158
- STEPHANIE GOOD, YOSEPH SHIFERAW, LENA DAVIDSSON, THOMAS RANDOLPH, RICHARD HURRELL:
Animal Source Foods and Nutrition During Early Life 159
- SOTHEARA EM, VATHANA SANN:
Extending Shelf-Life of Soy Sauce Using Acetic Acid as Non-Feed Additives 160
- BÜLENT TOPCUOĞLU, M.KUBILAY ÖNAL:
Heavy Metal Accumulation in the Eggplant (*Solanum melongena*) grown in MSW Compost Applied Soil 161
- M.KUBILAY ÖNAL, BÜLENT TOPCUOĞLU:
The Effect of Spent Mushroom Compost on the Dry Matter and Mineral Content of Pepper (*Piper nigrum*) Grown in Greenhouse 162
- ANDRÉ GORDON, ROBERTA B. RODRIGUES, FRIEDHELM MARX, MENELAOS PAPAGIANNOPOULOS:
Antioxidant Capacity of Tamarillo Fruit (*Cyphomandra betacea*) 163
- IVA VIEHMANNOVÁ, LUIGI MILELLA, ELOY FERNÁNDEZ CUSIMAMANI, JAROMÍR LACHMAN:
Chemical Composition of Tuberos Roots and Leaves of Yacon [*Smallanthus sonchifolius* (Poepp. et Endl.) H. Robinson] 165
- ANDREW NGEREZA, ANNA KEUTGEN, ELKE PAWELZIK:
Quality of Mango, Passion Fruit and Pineapple in Tanzania 166
- MAIKE LANGKAU, EVA SCHLECHT, ANDREAS BUERKERT:
Assessing Agricultural Sustainability and Food Security in Nagaland (N.E.-India) 167
- KAMORU ADENIRAN, OLUDARE BABATUNDE:
Assessment of Nigeria Food Security Situation 168
- MOHAMED BABEKIR ELGALI, RAJAA MUSTAFA, SIEGFRIED BAUER:
Supporting Sudanese Agriculture to Improve Food Security 169
- DETLEF VIRCHOW:
Increasing Vegetable Production and Consumption in Africa: Averting the Downward Trend of Malnutrition and Poverty 170

ASHENAFI GEDAMU: Triticale Crop and Food Security, and Determinants Influencing the Adoption of Triticale: Example from the Amhara Region, Ethiopia	171
CHRISTOPH EHLERT, HERMANN WAIBEL, DAGMAR MITHÖFER: Food Safety Standards, Farm Size and Farm Worker Welfare in Kenya	172
INGRID FROMM, UTZ DORNBERGER: Standards: An Imperative for Integration in Value Chains? Evidence from Agricultural Producers in Honduras	173
DAMIAN M. GABAGAMBI: Identification of Food Safety Compliance Costs: A Case of Nile Perch in Tanzania	174
TILL STELLMACHER, ULRIKE GROTE, JÖRG VOLKMANN: Reappraising Ethiopian Forest Coffees: Prospects and Challenges of Fair Trade Certification	175
PARICHAT THEANJUMPOL, SA-NGUANSAK THANAPORNPOONPONG, ELKE PAWELZIK, SUCHADA VEARASILP: Milled Rice Physical Properties after Various Radio Frequency Heat Treatment	176

Linking African vegetable smallholders to high value markets: Potentials and constraints in smallholders integration into EurepGAP-certified and/or domestic African high-value supply- chains

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This research project analyses the opportunities, challenges and constraints in linking smallholder vegetable farmers to high-value supply chains (SC) in different Sub-Saharan African (SSA) countries.

The project assumes that innovative small-scale vegetable producers delivering to traditional markets can improve their profit margin by strategically directing their production either to the export market or to high-value domestic market.

The export market bears considerable risks as it is highly demanding and volatile. E.g. exporting to the EU market increasingly requires compliance of private standards such as EurepGAP. The certification is often very costly and associated with a lot of paperwork. Statistics of EurepGAP for SSA revealed that only isolated cases of successful smallholder certification exist. There is increasing evidence that the fluctuation of smallholders involved in EurepGAP certification is considerably high. The project identifies the factors, which lead to the high dropout rate of smallholders from the EurepGAP certification scheme. Furthermore the project investigates institutional modes how smallholders can successfully cooperate with agricultural enterprises holding a EurepGAP (option1) certificate and therefore their own costly certification can be avoided.

A second option for smallholder vegetable producers is to target the high-value domestic supply-chain (SC) which may include supermarkets, upper-class hotels and other tourism-related businesses. Quality is generally assessed by visual judgment and is often within the responsibility of the SC purchasing manager. The example of a supermarket chain in Tanzania showed that besides quality the criteria of supply reliability in terms of time (timely delivery) and amount (sufficient volumes) are crucial factors for a sustainable business relation.

The research team investigates (i) the obstacles and potential of smallholder integration in high-value domestic value chains and (ii) institutional and organisational requirements of smallholder groups and their intermediaries in these SC.

Methodologically the study follows a comparative case study approach by carrying out market assessments of smallholder integration in both, international export and domestic high-value SC in four African countries. The results are of primary importance to smallholder groups, agricultural market development services and donors as a framework is provided to assess under which conditions linking smallholders to high-value SC appears a promising strategic option.

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Keywords: Africa, high-value agriculture, smallholder, supply-chain, Tanzania, value-chain, vegetable

Food Quality, Safety Measurement and Control: The Future Challenge for Indonesia

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Some recently emerged food scandals happened in Indonesia such as the uses of formalin, borax and Rhodamin B in some traditional fresh food products have jeopardised the consumers trust in food products in general. Currently, the Indonesian consumers demand for consuming high quality and high safety food products. Although in the past the government and food authority have seriously taken several different improvement measurements for ameliorating food quality standard, however due to the complex market structures, apparently, this measurement did not yet achieved an optimal result. Moreover, due to limited capacity possessed by the food authority, the enforcement of regulation is mainly directed to the medium to big food manufactures. Significant quality and safety measurement programme supposed to be applied for small, moving or home made food producers such as street food producers and small restaurant called “warung” or family-based food producers are still absent. Unfortunately, these sectors carry a high risk for mal-practicing the food quality and safety standard. Moreover, since these producers contribute roughly by more than 20 % of the total national food consumption, especially in urban cities and they can be considered as important food supply chains for adult and children, therefore, we argue, that it is now obviously relevant to start thinking on the future improvement possibilities can be done for these sectors. Therefore, this paper aims **(a)** to identify the problematic issues concerned with street food vendors and small/family-based food producers and **(b)** to propose a plausible food quality and safety improvement relevant for these sectors.

In a nutshell, this paper suggests that consistently performed programs such as identification/registration, certification (from government and independent institutions), training/education for vendors, controlling measurement, education and control of controllers, modification of eating culture of the consumers, further improvement on the consumers’ awareness on food quality and active participation of the consumers and market competitiveness can be considered as some important measurements that can be applied for this sector. The international codes of hygienic practices for the preparation and sales of street foods can be used as basic models for developing the Indonesian guideline.

Keywords: Eating culture, quality control, sanitary, small food vendors, street foods

Influence of the Addition of Okra Seed Flour on the Properties of ‘Ogi’, a Nigerian Fermented Maize Food

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‘Ogi’ is a popular infant weaning food and breakfast meal for adults in Nigeria and in most part of West Africa. Traditionally, it is prepared from maize, sorghum and millets paste. It is often marketed as a wet cake wrapped in leaves or transparent polythene bags. Enhancement of the nutritional quality of foods is a means of combating diet related diseases in human race.

Okra seed flour was added in various proportions (0-50 %), to ‘Ogi’ a Nigerian fermented maize food. The effects of such additions on some nutritional, physico-chemical and sensory properties of the products were investigated. Data obtained indicated significant increases in the levels of protein, ash and fat, but reductions in the levels of carbohydrate and moisture with increases in the proportion of okra seed flour. Increases were also recorded with respect to the contents of Vitamin C, Calcium, Sodium and Iron. Moreover, while the pasting temperature (Tp), gelatinisation time (Mg), and the time to reach peak viscosity (Mn) all increased, though gradually, the peak viscosity during heating (Vp), viscosity after 30 min (Vr) and final viscosity on cooling to 50°C (Ve) showed significant decreases with increasing proportions of okra seed flour. These produced consequent effects on the stability of starch and ease of cooking of each mixture. Although the addition of okra seed flour to ‘ogi’ may have the potential to improve the nutritional status of ‘ogi’, data on sensory evaluation indicated only a slight level of consumer acceptability of the resulting products. The need for supplementation with colouring and flavouring agents may therefore be advocated.

Keywords: Nutritional value, Ogi, Okra, physicochemical properties, sensory evaluation

Comparison in Cup Quality of Arabica Coffee from Yunnan, China

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Yunnan is the only coffee plantation province in China. It comprises three Arabica plantation regions (Dehong, BaoShan and Simao). The Arabica species are particularly sensitive to a disease called “coffee leaf rust disease” (*Hemileia vastatrix*). It is the major constraint for coffee production there. To overcome this serious epidemic problem, Catimor varieties, known for their coffee rust resistance, were introduced in Yunnan at the end of the 20th century. In recent years, low coffee prices in the market caused an international coffee production crisis. In almost all coffee producing countries, such low prices are unable to cover production costs and have led to serious social and economic problems. The present arabica germplasm from Yunnan was screened for taste quality. The 52 best samples were rated by a professional cup cup taster group in Berlin and the 17 best samples of this cupping were submitted to a consumer taste panel in Bonn. Basing on the results from the coffee cup testing and on complementary physical and chemical data, new ways are explored to reduce the incidence of coffee rust and to increase the income of coffee farmers in China. The results of the cup testing show that the quality of Catimor cultivars is not worse than traditional cultivars in China. They combine coffee rust resistance with relatively high productivity characters resulting in lower production costs. Moreover, the three main coffee plantation regions are compared for cup quality in order to find the environmental conditions in China which are best for cup quality. Finally, the study will focus on the shade or non- shade problem in coffee growing. According to the physical data (e.g. the fraction of beans in different sizes, the weight of 1000 beans and the ratio between the fresh fruits and the dry beans) and the cup testing results, we can determine whether shade trees have positive effects on the quality of coffee in China. It not only raises the local farmers’ income from coffee growing but also adds the extra benefit from the sales of by-products from shade trees. In addition, we will try to find the relationship between taste quality and the chemical components of coffee beans e.g. caffeine, trigonelline and chlorogenic acid.

Keywords: *Coffea arabica*, cup quality, germplasm, income, Southwest China

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Enhancing Food Quality and Safety in a Rural Habitat — A Holistic Perspective

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Food Quality and chemical safety is a growing area of global concern because of its direct bearing on human health. Hence, world over to tackle food safety issues alternative agriculture systems like organic farming, biodynamic agriculture, permaculture, pesticide free farming etc are being developed and propagated. However, due to several socio-cultural and technical reasons, diffusion and acceptance of these technology packages among the farming community in developing countries like India has been very slow. Hence, it becomes urgent and important in the transient phase that some pragmatic solution should be developed.

Food legumes form an important part of the human diet on account of their high nutritive value. Soybean is one of the most commonly consumed legumes worldwide. Present paper discusses the scientific validation of enhancing the nutritive value of soybean through simple, cost effective culinary processes which have been in use in the rural sector. Experimental data reveals that the different treatments affect the nutritional quality of the pulses studied. However, microwave cooking and germination caused smaller losses in nutrients, while ordinary cooking and pressure cooking caused considerable losses. Carbohydrate constituents (reducing sugars and total soluble sugars) showed increase on processing while the starch content showed a decreasing trend which is prominent during pressure cooking. The total protein content showed a significant increase during germination. The mineral content showed considerable variation during the processing treatments. Further R&D work on unlocking the complex food matrix i.e enhancing the bioavailability of nutrients in pesticide contaminated pulses is warranted.

Keywords: Bioavailability, nutrients, pesticide, processing

Socioeconomic Impacts of Adulteration in Goat Cheese Production to Public Health in Brazil

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The authenticity of foods became a serious world-wide problem. It is becoming more and more important to detect the introduction of adulterated food in the market. The adulteration of goat cheese is becoming more frequent in Brazil. Seasonality in production of goat milk and higher prices than those for cow milk are the main reasons why producers are adulterating goat cheese. Preliminary results show that each year about 70 to 245 thousands of new cases of allergy to cow milk in children up to 12 months of age are reported in Brazil. Thus, the development and adoption of fraud detection techniques become compulsory. This study aims to assess the socioeconomic impacts of adulteration of goat milk products with cow milk. The main impacts to the public health system are related to the cost of treatment of allergic children after consuming cow milk instead of goat milk products. In Brazil, the most used methods to detect IgE antibodies, which are responsible for the allergy, are the RAST and the skin test with immediate result. Another alternative is to remove cow milk from allergic children' diets. These treatment and prevention methods are expensive and hard to implement in public health programs. Genetic techniques like molecular markers became useful to check the quality of new food products, enabling the identification of origin of components of contained in those products. With this technique it is possible to detect cow milk in goat cheese through the differences of molecular weight of the β -casein fragments. With this study it was possible to show that, comparing to other techniques, molecular markers represent a fast and cost-effective method to detect goat cheese adulteration with cow milk. This improves food safety to consumers with cow milk allergy and thereafter, increases the demand for original goat cheese, benefiting the whole chain, including farmers, dairy industries and traders.

Keywords: Allergy to cow milk, economic of biotechnology, goat cheese, molecular markers

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Assessing the Impacts of Agricultural Biotechnologies in the Tropics

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The application of biotechnology-based products to respond to critical needs in the agrifood and environmental management sectors of developing countries is an integrated set of activities designed to identify opportunities for biotechnological innovations, and to overcome key bottlenecks to their effective application.

This decision reflects recognition of the need for careful, rigorous analysis of the social, economic, and environmental impacts of agricultural biotechnology applications. From the outset, it was felt that this should be a crucial part of the overall work program, an essential complement to activities geared to promoting the transfer and application of specific biotechnology-based products, and improving the capacities of biotechnology-based enterprises.

Understanding the way in which biotechnology applications affect socioeconomic and environmental variables is not simply an academic exercise. Impact assessment data is important to a range of decision-makers % from public sector research agencies involved in supporting biotechnology research; to regulatory bodies charged with granting approvals for the introduction of specific products; to a range of private sector and nongovernmental actors faced with decisions regarding future investments in the adoption and application of biotechnology-based products.

Unfortunately, the very diversity of interests at stake complicates the task of assessing the impacts of particular biotechnology applications. The impact analysis approach the issue from differing perspectives and with differing needs in terms of the type of information and level of detail they require. The point of view and methodological approach of a university-based research are likely to differ widely from those of a regulatory office. More broadly, it will underscore the need for a consultative approach to impact assessment to ensure that the broadest possible range of interests is reflected in the analysis. This is essential not simply to improve the quality of analysis but also to ensure a strong constituency of public support for resulting policy decisions. Ensuring a balance between scientific rigor and public participation is by no means an easy task, but it is essential to ensure the effectiveness and credibility of impact assessment exercises.

Keywords: Biotechnologies, tropics

Evaluation of the Nutritional Status of Children under Age of Five in Relation to their Feeding Patterns: Case Study-El Fau Rural Area, Sudan

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In the El Fau rural area of Gadarif state, the villages 11, 14 & 15 were selected due to their ideal characteristics for investigation [e.g., illiteracy, rampant poverty, lack of basic health services, unsafe drinking water, high prevalence of malaria, bilharziasis and diseases related to poor sanitation & hygiene].

Mothers were asked regarding breastfeeding, weaning practices, complementary feeding & feeding patterns after weaning. Children were examined to indicate the clinical signs of protein energy malnutrition, nutritional anaemia, vitamin A deficiency and iodine deficiency disorders (IDD).

The results indicated that the high illiteracy among mothers (76.7 %) affected the children feeding patterns, where 100 % of the infants were fed by KISRA blended with water in the early month of breastfeeding (≤ 4 month). Their complementary foods were ACEDA, WEIKA & ROUB beside milk. The lack nutritional education, where the importance of the food diversification (ACEDA, WEIKA, fresh or cooked ROUB & milk) coupled with insufficient daily food intake may represent stumbling block for the well-being of the children. Added to that the wrong feeding habits of the family during which the children (50 %) share adults the same family's pot. This situation leads to the prevalence of wasting where 6 % of the children are moderately malnourished and 3.3 % are severely malnourished. In addition to that, high prevalence of nutritional anaemia was shown, where 65.3 % of the children with haemoglobin concentration of 50 % or below. None of the children were suffering from vitamin A deficiency because of the continuous national Expanded Programme Immunisation (EPI), which included distribution of vitamin A capsules. None of the children were found suffering from Goiter, which indicates that IDD in this area was very seldom.

Keywords: Children under 5, feeding patterns, malnutrition, nutritional anaemia, rural area

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Assessment of Meat Production and Meat Processing in Niamey/Niger: Hygienic Quality of Fresh Meat and of the Dry Meat Product “Kilishi“

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Due to overall population growth, increasing urbanisation and changing dietary habits, meat consumption is increasing in Sub-Saharan Africa. In view of this, the present study assessed hygienic aspects of current meat production and processing practices in Niamey, Niger. During September - December 2006, the microbiological quality of the dry meat product “Kilishi” (n=2 samples), which was produced by means of a solar dryer, was determined and compared to literature data for dry meat products produced in the traditional way. Lead concentrations in meat samples (n=3) were determined before and after transport from the abattoir to the markets and before and after being processed into Kilishi (n=4). Qualitative interviews with Kilishi producers (n=8) and a quantitative consumer survey (n=58) were conducted in order to determine subjective quality criteria for Kilishi.

The results showed that slaughtering of cattle and small ruminants and carcass processing take place under unhygienic conditions at the out-dated city abattoir and that refrigeration facilities are only used to a marginal extend. Meat transport is done on open pickup vehicles without refrigeration and protection against sun and dust. However, lead concentrations in fresh meat samples after transport were low. Kilishi is traditionally produced by direct sun drying, and the cut lamellas of meat are not protected against dust or flies. After drying, the meat is covered with a spicy peanut sauce (Kilishi Ja and Fari) dried again and grilled. Another type of Kilishi (Rumuzu) is only seasoned with salt and spices before being grilled. Microbiological and chemical analysis of solar dried Kilishi resulted in low counts of indicator organisms and lead concentrations while the traditional products were highly contaminated with bacteria and lead. Interviews of Kilishi producers revealed that established recommendations for the improvement of Kilishi production are not applied because official advice and control is lacking and producers' knowledge concerning hygienic aspects is poor. Most consumers (70 %) were satisfied with the hygienic conditions at street production sites for Kilishi, and the solar-dried Kilishi Ja was less appreciated than the respective traditional product.

Keywords: Dry meat, lead contamination, meat quality, Niger

An Evaluation of the Nutritional and Physicochemical Properties of Candies from Imitation Milks

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Milks manufactured from plants such as soybeans, coconuts and groundnuts, when carefully formulated, can be of considerable importance nutritionally and produced at a lower cost than natural milk. Plant milks are quite nutritious and only slightly different from animal milk in their composition. One of the ways of utilising animal milk is in the production of candies. However, candies made from animal milks are quite expensive and not readily available in developing countries hence the consumption of candies is regarded as being luxurious.

In this study, imitation milks from soybeans, coconuts, and groundnuts were utilised as raw materials in the production of candies. The nutritional composition of these crops greatly reduced due to processing procedures as they were processed into candies. Nutritional, physicochemical and sensory evaluation of these products were analysed and compared with candies from animal milk. Plant-source candies compared favourably well with dairy-source candies in all the measured properties. The highest protein level of $6.43 \pm 0.08\%$ was recorded in soy-candy. The candies had low levels of fat which was an advantage for the keeping quality of the candies as chances of rancidity would be reduced. The moisture content was between 4.37 ± 0.06 and $5.93 \pm 0.03\%$. Microbial growth is directly linked to moisture content and water activity of food hence at this moisture content the candies can be stable under adequate storage conditions. The results of sensory evaluation indicated that coconut candies, groundnut candies and dairy-candy were given same preference in all quality attributes. The inherent unpleasant flavour of soybeans negatively affected the panellists' preference for soy-candy.

Large-scale production of candies from imitation milks is a way of expanding the use of under-utilised crops in some developing countries and also creation of job-opportunities as well as encouraging scientific researches on other crops for food products development.

Keywords: Candies, imitation milk, nutritional value, physicochemical properties, sensory evaluation

Animal Source Foods and Nutrition During Early Life

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The diets of populations in developing countries are based on starchy staple foods. Animal source foods (ASFs) are important sources of energy, high quality protein and bioavailable micronutrients but are often consumed in small quantities. This project is focusing on consumption patterns of ASFs in young children in Ethiopia and the pathway by which livestock keeping influences their consumption patterns.

Almost 300 families with infants 6 months old at the start of the study were visited during one year to collect data on dietary consumption patterns, growth and morbidity. A blood sample was drawn at the end of the study. Information about the socio-economic status of the families was collected.

Preliminary results:

The mean family size in rural households was 5.4 compared to 4.9 in urban households. In general, the yearly income of urban households was higher than of rural households (4561 ± 368 Birr compared to 3418 ± 277 Birr).

Cows' milk had been introduced to 46 % of children by the age of 6 months (at least once daily in 93 % of these children, but many mothers (64 %) diluted milk with water). At 6 months, 9 % of children were fed eggs at least once a week, while at 18 months 44 % were fed eggs at this frequency. The most frequently consumed food at 18 months (98 % of children) was injera, a fermented staple food.

Growth was impaired during the period 6 to 18 months, a pattern typically found in resource-poor areas. At 6 months, less than 10 % of the children were stunted. One year later, almost 50 % were stunted (height-for-age Z-score below 2 standard deviations of mean of reference population). Blood analysis (n=242) indicated high prevalence of anemia at 18 months; 68 % (cut off 110 g l^{-1}).

These results highlight the poor nutritional status of young children in the Ethiopian highlands. Further analysis will evaluate data on agricultural economics, consumption of ASFs and child nutrition in more depth.

Keywords: Agricultural economics, animal source foods, Ethiopia, infants, nutrition

Extending Shelf-Life of Soy Sauce Using Acetic Acid as Non-Feed Additives

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Soy sauce, a processing product of soy, is a traditional food recipe in Cambodian cuisine. Acidic flavour and shelf-life of soy sauce is normally increased by the addition of acid sulphuric. Seeing the fatal problem and food safety risk of using this additive, acetic acid can be an alternative option. This experiment aimed at optimising the level of acetic acid to be added in soy sauce to extend shelf-life of soy sauce.

The process of making soy sauce was to toast, grind, and boil full-shape soy bean with HCl (15%), and then de-acidify the sample with NaCO₃. After stirring and filtering process, the liquid material was boiled and added with 4, 6, and 8% of acetic acid in respective to the treatment level. After storing for 3 days, soy sauce was pasteurised and packaged. The pH value, acidity, protein, and the sensory testing of soy sauce in these 3 treatments were collected after 15 and 30 days of storing.

On the 30th day, the pH values among treatments were 4.8, 4.6, and 4.5 respectively. The acidity of soy sauce was 1.9, 2.5, and 3.6% in treatment 1, 2, and 3 respectively ($p < 0.05$). It was observed no significant difference in protein level among treatments. Using up to 8% of acetic acid in soy sauce resulted in no adverse affect on its acidic flavour. Soy sauce in treatment 1, 2, and 3 were scored 3.0, 3.5, and 3.6 on 5 for the general consumer preference respectively. No significant difference in odour, colour, and liquidity of soy sauce among groups was observed. Storage period from 0-30 days had no effect on the tested variables.

Using up to 8% of acetic acid provided a high value of consumer preference. Increasing the amount of acetic acid has no effect on shelf-life extension of soy sauce. Further research should be carried out to determine the optimum amount of acetic acid to be added to soy sauce.

Keywords: Non-feed additives, soy sauce

Heavy Metal Accumulation in the Eggplant (*Solanum melongena*) grown in MSW Compost Applied Soil

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A pot experiment was conducted to investigate the effects of soil applications MSW (municipal solid waste) compost on the fruit yield and heavy metal accumulation in the leaf and fruit of eggplant plant (*Solanum melongena*). Red Mediterranean soil collected from the surface (0–30 cm) of fields cropped in a wheat-corn rotation in Antalya (Turkey) was used as an experimental soil. The heavy metal content of untreated greenhouse soil was well within the accepted normal range of values. Pots containing different amounts (corresponding to 0, 25, 50, 100 and 200 ton ha⁻¹, as dry weight basis) of MSW compost were used to grow eggplant plants under controlled greenhouse conditions. Zn, Cu, Ni, Pb, Cd and Cr contents in the leaves and fruits of eggplant were determined as well as the Fruit yield. MSW compost applications led to greater fruit yield at low application rates, but higher application rates (100 and 200 ton ha⁻¹) of MSW compost depressed plant growth and fruit yield. It was found that the MSW compost applications brought about a sharp increase for heavy metals in the plant material. At low MSW compost treatments, the concentrations of heavy metals in plants were below the phytotoxic levels. However, in the high MSW compost treatments, according to background and toxicity limits, heavy metal status of leaves and fruits were ranged at high levels, and Pb and Cd concentrations in eggplant fruits were exceeded foodstuff index and limit values for edible vegetables. The resulting data demonstrate that the MSW compost was a source of heavy metals for the soil and MSW compost application caused an important accumulation of heavy metals in eggplant.

Keywords: Eggplant, heavy metals, MSW compost

The Effect of Spent Mushroom Compost on the Dry Matter and Mineral Content of Pepper (*Piper nigrum*) Grown in Greenhouse

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This research was carried out to determine the effects of spent mushroom compost (SMC) as an organic material source for pepper grown in greenhouse soil. SMC was collected from mushroom cultivation plant in Korkuteli representative of the major mushroom growing area of Turkey. Pepper plants were grown in pots containing different amounts of SMC (corresponding to 0, 15, 30 and 60 ton ha⁻¹, as dry weight basis). Red Mediterranean soil collected from the surface (0–30 cm) of fields cropped in a wheat-corn rotation in Antalya (Turkey) was used as an experimental soil. The heavy metal content of untreated greenhouse soil was well within the accepted normal range of values. The effects of SMC on dry matter, N, P, K, Ca, Mg, Fe, Zn, Cu, Ni, Cd and Pb contents of pepper were determined. SMC applications caused statistically important effects on dry matter yield, and N, P, K, Fe and Zn contents in the pepper plant. SMC applications increased yield until 30 ton ha⁻¹, higher application rates of SMC compost depressed plant growth. All spent mushroom compost treatments, except control resulted in higher mineral content. However, no important changes in heavy metals were detected. All metal concentrations were below the phytotoxic maximum limits. The best result in regard to productivity was obtained at 30 ton ha⁻¹ SMC applications. At 60 ton ha⁻¹ SMC applications pepper yield was depressed due to the high salt content. This research showed that SMC could be applied in greenhouse soil at the agronomic rates without heavy metal and salinity defects.

Keywords: Pepper, heavy metals, SMC compost

Antioxidant Capacity of Tamarillo Fruit (*Cyphomandra betacea*)

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A research project (PAVUC) supported by the European Union centres the development of fruit products with added values for the human health out of so far underutilized fruits from Latin America. Among others, investigations were performed on tamarillos that originate from the Andes and are increasingly offered on European fruit markets. Evaluation of the antioxidant capacity was implemented by using the GC based Total Oxidant Scavenging Capacity (TOSC) assay. This method allows the assessment of the antioxidant activity of samples against peroxy radicals, hydroxyl radicals and peroxynitrite - three reactive oxygen species (ROS) of physiological relevance.

In total two red and one yellow variety of tamarillo were examined. Results demonstrated an intermediate antioxidant activity towards peroxy radicals and peroxynitrite whereas the red varieties performed better than the yellow. Towards hydroxyl radicals no cultivar related differences could be constituted.

Determining the antioxidant activity of different edible parts the pericarp, the seed jelly including the kernels dominated in comparison with the fruit pulp in reference to the three different investigated ROS. However, only a small variation occurred towards hydroxyl radicals.

Ascorbic acid was identified as a potent antioxidant constituent in tamarillos. Its antioxidant efficiency is good against peroxy radicals. Towards peroxynitrite ascorbic acid demonstrates a moderate antioxidant behaviour. No activity in relevant concentrations was exhibited towards hydroxyl radicals. Amounts of ascorbic acid were 4.5 fold higher in the seed jelly rather than the fruit pulp. Compared to oranges, tamarillo fruit contains a similar amount of ascorbic acid (between 25—30 mg/100 g fresh weight of the edible part) but shows a pronounced higher TOSC value against peroxy radicals which may be explained by the presence of anthocyanins. The seed jelly contains in total eight anthocyanins which are derived from the aglycons cyanidin, delphinidin, and pelargonidin. A pelargonidin-hexosyl-desoxyhexoside and a cyanidin-hexosyl-desoxyhexoside dominate quantitatively within the seed jelly. Furthermore a variety depending difference concerning the anthocyanin pattern was revealed.

Anthocyanins were proven to be good antioxidants against peroxy radicals but not against peroxynitrite and hydroxyl radicals. The measured activity against the both latter suggests that maybe other compounds take part in antioxidant reactions.

Keywords: Antioxidant capacity, hydroxyl, peroxy, peroxynitrite, tamarillo, TOSC

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Chemical Composition of Tuberos Roots and Leaves of Yacon [*Smallanthus sonchifolius* (Poepp. et Endl.) H. Robinson]

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Yacon [*Smallanthus sonchifolius* (Poepp. et Endl.) H. Robinson] a native tuberous plant of the Andes, belongs to the family *Asteraceae*, is cultivated for its tuberous roots and medicinal infusions obtainable from the leaves. It is very rich in phenolic components with strong antioxidant activities. Most of tuberous root biomass is constituted by water usually almost 70 % of the fresh weight. When grown under its native climatic conditions yacon tuberous roots contain saccharides, especially oligofructans (with favourable effect on diabetes), form 70–80 % of dry weight (d.w.), otherwise protein contents range between 0.3–3.7 % d.w. The overground part of yacon contains a great amount of proteins (up to 25 % d.w.) and can be used like forage.

Yacon was introduced in Czech Republic 11 years ago, where at the present time it is cultivated successfully. It reaches relatively high yields of biomass: up to 34 t ha⁻¹ of tuberous roots, t/ha of overground part, 14 t ha⁻¹ of fresh leaves and 2 t ha⁻¹ of dry leaves.

The purpose of this work was to determine the chemical composition in primary and secondary metabolites in the tuberous roots and leaves of yacon cultivated under Czech climatical condition.

Yacon tuberous roots, grown in Czech Republic contain saccharides: inulin (179 g kg⁻¹ d.m.), fructose 193 g kg⁻¹ d.m.), saccharose (28.6 g kg⁻¹ d.m.) and glucose (69.3 g kg⁻¹ d.m.).

Phenolic acid content was measured in the roots: chlorogenic acid (942 mg kg⁻¹ d.m.), caffeic acid (329 mg kg⁻¹ d.m.), 3,5-O-dicaffeoylquinic acid (249 mg kg⁻¹ d.m.). Protein content in the tuberous roots is 154 g kg⁻¹ d.m.

Phenolic acid content of yacon leaves was measured too, it demonstrated to be definitely different than the root's one in each of the component measured but in the chlorogenic acid. In fact acid content in dry leaves was: chlorogenic acid (779 mg kg⁻¹ d.w.), caffeic acid (699 mg kg⁻¹ d.w.), 3,5-O-dicaffeoylquinic acid (9018 mg kg⁻¹ d.w.). The content of protein in leaves is 252,5 g kg⁻¹ d.w. It is interesting to underline that compared with potato tubers (834 mg kg⁻¹ d.m.), yacon tuberous roots (8489 mg kg⁻¹ d.m.) are 10 times richer in polyphenolic antioxidants.

Keywords: 3,5-O-dicaffeoylquinic acid, phenolic acid, proteins, saccharides, yacon

Quality of Mango, Passion Fruit and Pineapple in Tanzania

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Tanzania has a wide range of agro-climates suitable for the production of a large number of agricultural products. In many of these agro-climatic zones the available production potential is not fully utilized. For example, Tanzania has the potential to produce 2,000,000 metric tons of fruit worth at least US \$ 900,000. About 40 % to 60 % of these fruits are wasted, because processing and preservation facilities are not available. Recently, the importance of organic farming has increased, so that ecologically produced fruits are available on markets. The present study intended to evaluate parameters, which play a role in quality evaluation of organically grown mango (*Mangifera indica* L.) cv. 'Dodo', yellow passion fruit (*Passiflora edulis* f. *flavicarpa*) and pineapple (*Ananas comosus* L.) cv. 'Smooth Cayenne' to meet local and international market standards. Special emphasis is given on compounds that contribute to human health, such as vitamins (mainly ascorbic acid) and mineral nutrients. Further quality parameters to assess nutritional properties include fruit weight, color, juice percentage, soluble solids, and titratable acidity. Passion fruit was characterized by the highest ascorbic acid content (13.7 mg per 100 g), followed by mango (5.2 mg per 100 g), and pineapple (4.2 mg per 100 g). However, pineapples showed higher Brix values of 15.4 % than mangoes (14.8 %) and passion fruits (14.6 %). The percentage of juice was higher in mango (57.9 %) than in pineapple (48.8 %) and passion fruit (45.4 %), while passion fruit had a higher percentage of titratable acidity (8.5 %) compared to mango (2.4 %) and pineapple (1.4 %). Pineapples and mangoes are consumed as fresh fruits and are also processed to juice, while the yellow passion fruit is mainly processed to juices and nectars.

Keywords: Ascorbic acid, Brix value, mangoes, passion fruits, pineapple, titratable acids

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Assessing Agricultural Sustainability and Food Security in Nagaland (N.E.-India)

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Little is known about the sustainability of the landuse systems and people's food security in Nagaland (North-East India) where a population growth of 6.3 % leads to an apparent shortening of the fallow period and concomitant decline in soil productivity. This situation is especially severe in the study area of the Mon District, where 93 % of the population depend on shifting cultivation. An initial survey revealed that fallow periods have been reduced to five years and additional land for cultivation is hardly available. This study was carried out in two villages, Hongphoy and Minyakshu of the Mon District to quantify the gap between local farmers' food demand in cereals and amounts harvested on the so-called Jhum fields as dependent on population density. Data collection comprised comprehensive interviews of family size, food consumption, crop yields and duration of fallow period in households as well as the determination of field sizes over two years.

The data revealed that the available per caput area for Jhum cultivation averaged 1,800 m² in Hongphoy and 1,200 m² in Minyakshu, compared to a minimum requirement of 2,000 m² for subsistence purposes. The daily caloric intake from harvested cereals such as rice (*Oryza sativa* L.), millet (*Pennisetum glaucum* L.) maize (*Zea mays* L.) and from additionally bought rice from Assam was about 8190 to 8715 KJ (1,950 to 2,075 kCal) in the years 2004 and 2005. These values are far below the food-security thresholds defined by FAO. While in Hongphoy 16 % of the caloric intake came from bought Assam rice in 2004 and 29 % in 2005, these figures were about 83 % and 85 %, respectively, for Minyakshu, which means that the formerly autonomous village of Minyakshu depends much more strongly on additional food supplies than Hongphoy. This leads to an almost Malthusian scenario. Even improved agricultural practices such as improved fallow systems with *Alnus nepalensis*, the construction of irrigated rice terraces or the cultivation of higher yielding rice varieties were unable to fill the food gap of 277 tons rice in Hongphoy and of 1,219 tons in Minyakshu in 2004.

Keywords: Agricultural sustainability, food security, India, Nagaland, per caput area, population growth, shifting cultivation

Assessment of Nigeria Food Security Situation

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An assessment of food security situation in Nigeria was carried out by tracing the trends in food supplies since independence. Before the civil war in 1967–1970, Nigeria was self-sufficient in food production. The problem of food inadequacies started during the civil war (1967–70) when agriculture inputs and machinery as well as other items were deliberately curtailed to conserved foreign exchange. These problems eased after the civil war but resurfaced in 1974 as windfalls from crude oil export result in further neglect of the agricultural sector. The period, 1974 to early 1980's witnessed massive movement of labour and other productive resources away from the agriculture sector to other sector of the economy where returns were higher. Also there were massive importation of food as during this period. Imported food items rose from 2.1 million in 1974 to 3.3, 3.5 and 3.74 million dollars respectively in '77 '78, '79 respectively. The food import bill rose from a mere 0.9 million dollars in 1970 to 1974 to 7.45 million dollars 1981. Even with this per capital calorific food supply declined from the surplus of the 1960s to a deficit of 38 percent in 1982. The share of agriculture in total exports to merely 2 percent during this period. This lead to neglect of agricultural sector and the drift of labour force from the rural areas to the urban area during the 'oil boom era' which have cause the first major short fall in foods supply. The effort of the Federal Government in arresting the short falls in food supply through enunciation of different agricultural policies, which were either poorly implemented. The Federal Government in an effort to create an enabling environment for the private sector participation government deregulates the economy in 1986 and introduced Structural Adjustment Programme (SAP) owing to high import component of agricultural input production cost rose and prices of stable food were found to have increased to a greater degree than the pre-sap periods. Other factors observed to have contributed to the shortage in food supply and high prices are in efficient storage facilities, poor transportation and inappropriate processing technology.

Keywords: Food security, food supply, processing technology, storage facilities

Supporting Sudanese Agriculture to Improve Food Security

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Although it is rich in natural resources, Sudan is classified as least developed, low-income and food-deficit country. In the year 2005 the production of cereals in Sudan dropped by half. Subsidizing grain sector has risen as one of the solutions to bridge transitory food insecurity in the country. This paper tries to quantify the impact of these subsidies on the supply of cereals, food security, government budget and country welfare as a whole. To realise the study objectives, a multi-market model for Sudan was developed. The model embodied important characteristics of agriculture in Sudan like substitution effects and the partial-dependency of the agricultural supply on rainfalls. Sudan has accelerated its measures of economic liberalisation in 2000 by removing subsidies, production and export taxes on agricultural commodities. By looking at the structure of the Sudanese crop production it is clear that export commodities compete food commodities on scarce resources since an increase in one price would lead to a shift of the resources away from producing food crops to export crops and vice versa. The impact of input subsidy on the national food security indicators revealed a decrease of 52% in food deficit which is more than that in the case of subsidising producer price in which the subsidy reduced the deficit by 20% only. On the other hand, the input subsidy has a positive effect on the vulnerable population that substantially decreased compared to the producer subsidies case, where the vulnerable population reduced only to 2% of the total population.

Keywords: Food security, multi-market, subsidy, Sudan

Increasing Vegetable Production and Consumption in Africa: Averting the Downward Trend of Malnutrition and Poverty

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Although vegetable production, marketing and consumption has the potential to contribute significantly to the development of especially the rural and poor population in Africa, its role is neglected in the nutritional and development discussions, especially that of African indigenous vegetables. Consequently, the production and consumption of vegetables in Africa is lacking far behind the world-wide average. Not only in the consumption (which is less than the WHO/FAO recommended minimum uptake of 200 g of vegetables/day/person), but also in the production of vegetables, Africa is bringing up the rear by producing annually app. 50 kg of vegetables per capita, which is less than half of the rate in most of the other regions of the world.

Based on the Asian experience, positive health and economic effects can be projected by increasing vegetable consumption and production in Africa: Increased consumption will reduce the devastating health effects of insufficient vegetable intake. Increased consumption will lead to an increase in production. Hence, an increase in employment is forecasted through the high labour demand for cultivation as well as the possibilities of food processing. Higher production and adding value to the produce on site will lead to increasing incomes for the producers.

These opportunities for Africa can only be yielded, if decision makers are willing to invest to improve the vegetable production, marketing and consumption. To increase the demand of vegetables, promotion and awareness raising has to take place, to increase the supply, improved technologies have to be offered and propagated. These investments will have a high return in improved health status of the population as well as being a motor for economic development, thus breaking the downward trend of malnutrition and poverty in Africa.

Keywords: Health effects, income and employment, pro-poor growth, value adding, vegetable consumption and production

Triticale Crop and Food Security, and Determinants Influencing the Adoption of Triticale: Example from the Amhara Region, Ethiopia

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An average 5 million Ethiopians out of the current (2007) estimated population of 76 million, have been living in critical food deficits annually. As the country's land resources are exhausted and land productivity diminished due to severe land degradation, new crop varieties and new technologies are required in order to increase domestic agricultural production for meeting the basic requirements of the population which is growing at a rate of over 2% p.a. In response to these fundamental problems of the sector and the deteriorating food insecurity situations, large numbers of technologies have been generated for the last many years. However, the adoption of new technologies by the small scale farmers which account 95% of the total area under crop cultivation in the country is quite limited. The adoption of new technologies by farmers under varying contextual settings is influenced by number of socio-economic, institutional, and demographic factors of the farming households. In that context, in particular triticale (*x Triticosecale Wittmack*) has come into the focus since the late 1990ies. Research results under taken in various districts of the Amhara Region, show that the crop provides at least twice as much yield as the traditional crop tef under similar agro climatic conditions and field treatments.

The study attempts: (1) to identify the factors that influence the decision by farmers to grow triticale, and examines the food security effects resulted from the adoption of the new crop in the Amhara region; (2) to address the question what factors influence farmers' to adopt the new crop, and how far tef could be substituted by triticale in order to increase food production and thus ensure food security in the Amhara region. As the preliminary results indicate the adoption of triticale crop is positively correlated for example, with the demographic characteristics such as household size and age of the household head; household labour; availability of extension services; farm size and land tenure system.

The planned presentation aims to highlight the procedural methods used in the study, and discuss the preliminary outcomes.

Keywords: Baking quality, food security, tef, triticale

Food Safety Standards, Farm Size and Farm Worker Welfare in Kenya

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Understanding the various mechanisms that influence welfare is an important factor in the development debate. Taking the example of EurepGAP in Kenya this study investigates the influence of private food safety standards on farm worker welfare and its difference between small and large farms. This differentiation is increasingly important on the background of concerns of decreasing smallholder share in horticultural export production in developing countries. To understand, how such standards influence worker welfare, Sen's functionings and capabilities approach is employed, which allows a multidimensional welfare assessment. Three basic functionings are analysed to assess welfare: the functioning of being trained, the functioning of earning a decent income and the functioning of being healthy. The survey was conducted in Kenya from June 2006 to October 2006. A two stage sampling procedure was applied to draw a random sample of 316 farm workers on small and large scale EurepGAP certified, as well as small scale non-certified farms. On basis of the collected data, functionings were estimated using a Multiple Indicators and Multiple Causes (MIMIC) structural equation model. The findings suggest that EurepGAP certification has a positive impact on welfare, since workers on EurepGAP certified small scale farms receive more training compared to workers on non-certified small scale farms. At the same time, the higher amount of training received does not translate into higher wages or better physical or health for workers on EurepGAP farms. When comparing large and small-scale EurepGAP certified farms, large farms contribute most to the functioning of earning a decent income, while the amount of training and the health status of the workers do not differ significantly between these farm types. Overall, the findings suggest that workers on large scale EurepGAP certified farms obtain a higher welfare in terms of training and income compared to small scale certified farms and that the welfare is lowest in terms of the three functionings on non-certified small scale farms.

Keywords: Capability approach, EurepGAP, farm scale, farm size, food safety standards, functioning, MIMIC

Standards: An Imperative for Integration in Value Chains? Evidence from Agricultural Producers in Honduras

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The number of literature and research related to standards and the value chain analysis has increased in recent years. Producers from developing countries participating in value chains are increasingly required to conform to standards. These standards can be set by international bodies (i.e. EurepGAP, ISO14000, SA8000 and HACCP) or private sector lead firms. Because of the changes in food consumption patterns in industrialised countries, standards have a greater role in international trade and can accelerate or impede the integration of small producers in value chains. There is evidence that the enforcement of standards leads to learning processes along the chain. Small-scale producers, in their interaction with local processors or exporters and international retailers, have the possibility to acquire new skills and knowledge while complying with standards. The type of trust relationship and power dependence among the actors can determine the successful integration of firms in value chains. For this purpose, 102 agricultural producers in Honduras were analyzed. These producers belonged to the coffee sector (n=42), the horticultural sector (n=38) and the oil palm industry (n=22). The research focused on determining whether the compliance with standards had led to upgrading of internal processes and products in the firm in order to secure a better position in the value chain. It appears that the implementation of standards has an effect on the upgrading activities of the firm, but only product upgrading was significant. Furthermore, the role of standards in the integration process of the firms was studied. The results indicate that firms that had complied with standards were more likely to have higher sales than firms that had not adopted any type of standards. Firms implementing standards could also expect a positive impact on the productivity and profitability. There was also a significant effect on the knowledge gain and the position of producers in the chain. In the case of Honduras, the implementation of standards appears to be a critical factor in the integration of agricultural producers in value chains.

Keywords: Compliance, Honduras, power dependence, upgrading

Identification of Food Safety Compliance Costs: A Case of Nile Perch in Tanzania

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Modern developments in technology coupled with increased income levels in developed economies have pushed their consumers to demand safe food stuff that is free of health hazards. Standards and grades in food have evolved with primary objective of providing internationally recognised information and quality assurance of food products on the market. However, the costs of compliance to the majority of smallholder farmers and business people in developing countries are increasingly becoming hard to bear.

In developing countries, the impact of compliance to trade is not clear as many firms cannot differentiate them from the traditional quality costs. The situation is further worsened by the fact that firms in developing countries are standard takers and not standard makers.

Identification of compliance costs is important for several reasons. First, it is useful to shed light on how these costs are divided into fixed and variable costs. Second, the differentiated complying costs can be informative to the firms in calculating firms' margin by illustrating the effect of compliance costs. Third, the identification can assist firms in building arguments for government support in terms of public investments.

This paper is designed to demonstrate the intricacies of EU compliance costs for firms in developing countries using Nile Perch in Tanzania as a case study. The implementation of EU food safety standards in Tanzania started in 1997 after the import ban by European Union claiming that there was a threat of pathogens in fish from East Africa. The import ban led to an amendment of the Fisheries Act 1970 to incorporate food safety standards based on EU Directives (91/493/EEC).

Keywords: Compliance costs, EU food safety standards, Nile Perch, Tanzania

Reappraising Ethiopian Forest Coffees: Prospects and Challenges of Fair Trade Certification

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Ethiopia is the worldwide origin of the *Coffea arabica* gene-pool. The understory of the montane rain forests in South-western Ethiopia comprises naturally regenerating coffee populations with a genetic diversity unique in the world. The high diversity in terms of genetic variety and terrain-specific characteristics such as soil and microclimate provides the Ethiopian forest coffees with a great potential of unique and outstanding flavour and aroma profiles ‘in the cup’. This feature distinguishes Ethiopia from all other coffee producing countries where selection processes led to great homogeneity of cultivars.

Local peasants traditionally collect wild coffee berries and sell them sun-dried to sebsabies, the local merchants. Prices are extremely low and do not provide financial incentives to promote production of good quality. Additionally, it is currently impossible to trace back whether coffee originates from the forest or garden or plantation production instead.

A major trend in global coffee demand is the emergence of a differentiated coffee segment with relatively high prices, like Fair Trade niche markets. In case of Ethiopia, it is argued that the coffee sector must head away from standardised and mediocre coffees and transform its unique ecological characteristics into a competitive advantage on the hard-fought world market. In this regard, attempts have been made to design specialised value chains and labels for “Ethiopian wild coffee”. However, in order to do justice to Fair Trade labelling standards, a set of principles and criteria have to be met.

Based on qualitative interviews and primary data, this paper evaluates the performance of the Fair Trade segment of the Ethiopian forest coffee sector with regard to the concrete context found on the local level. Some of the major criteria of Fair Trade standards are evidently suitable to the conditions prevalent in the Ethiopian coffee forests, e.g. the focus on smallholder-based production. Others, particularly infrastructural and institutional requirements are highly difficult or even impossible to be met in local level reality. Additional challenges of the Fair Trade niche market poses the criteria of traceability (geographically and with regard to production systems), and inadequate picking and on-farm processing practices, leading to reduced coffee quality.

Keywords: Biodiversity, coffee certification, Ethiopia, Fair Trade

Milled Rice Physical Properties after Various Radio Frequency Heat Treatment

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The purpose of this research was to study the effect of the radio frequency (RF) heat treatment on the quality of milled rice cv. Khao Dawk Mali 105. The experiment was conducted at the RF laboratory in the Postharvest Technology Institute, Chiang Mai University, Chiang Mai (Thailand). Milled rice samples, each of 500 g, were treated by the RF frequency at 27.12 MHz for 3 minutes at five different temperatures (room temperature, 45, 60, 75 and 90°C, respectively). Milled rice quality was evaluated, e.g. physical properties (grain colour, moisture content), cooking quality (hardness and stickiness) and the processing quality (pasting properties, viscosity). SPSS was used to analyse the variance of the data.

The results showed that treatment temperatures higher than 60°C affected the colour of the milled rice, e.g. lightness (L*-value) and yellowness (b*-value) increased. Also the cooking quality was influenced to that effect that the kernel hardness increased while the stickiness decreased. The pasting properties and especially the viscosity decreased too as they were determined by means of peak viscosity, through, breakdown, final viscosity and setback. The RF treatment at 90°C caused the strongest changes in milled rice quality. However, for most of the studied properties no significant differences were found if treatments at temperatures below 60°C were compared.

The results of our research are the first and need validation. Furthermore, for future research the evaluation of the sensory quality should be included.

Keywords: Heat treatment, milled rice, radio frequency

Determinants of technology adoption and implications for policy and program design

Oral Presentations	179
ADEBAYO AKINOLA, AREGA ALENE, REMI ADEYEMO: Determinants of Adoption and Intensity of Use of Balanced Nutrient Management Systems in Northern Guinea	179
LIFENG WU, DIEMUTH PEMSL, HERMANN WAIBEL: The Role of Farmer Training in the Diffusion of Biotechnology in Cotton in China: A Multi-Period Analysis	180
IMMACULATE NJUTHE NDUMA, INGRID-UTE LEONHÄUSER, SIEGFRIED BAUER: Agricultural Technology and Information Response Initiative (ATIRI) in Kenya: Influence of Intrinsic Farmer-Group Characteristics on Household Adoption of Demand-Led Improved Agricultural Technologies	181
SIMONE KRIESEMER, PATRICK GRÖTZ, VOLKER HOFFMANN: Adoption and Diffusion of Fish Ponds in Malawi	183
Posters	184
ELISABETH GOTSCHI, BERNHARD FREYER: Implications of the New Land Law in Mozambique on Collective and Individual Ownership and Natural Resource Management	184
BIRTE JUNGE, ROBERT ABAIDOO, DAVID CHIKOYE: Assessment of Past and Present Soil Conservation Initiatives in Nigeria, West Africa	185
TARIG GIBREEL, SIEGFRIED BAUER: Demand Estimation of Subsistent Farm Households in the Dry Land of the Sudan: Almost Ideal Demand System Approach	186
ANNITA TIPILDA, HENDRIK EGELYING, NIELS KÆRGÅRD: Impact Pathways Assessment of Research for Development Programme: A Dual Purpose Cowpea Breeding Programme of the International Institute of Tropical Agriculture in Northern Nigeria	187

DIEMUTH PEMSL, THONGPORN TONGRUKSAWATTANA, HERMANN WAIBEL: Technology Adoption in Aquaculture in Developing Countries: Genetically Improved Tilapia in the Philippines	188
BJÖRN SCHIPPERS, JANA JUHRBANDT, HEIKO FAUST, STEFAN SCHWARZE, JAN BARKMANN: Effects of the Interaction of Migration, Financial and Social Capital on the Adoption of Agricultural Innovation and on Social Stratification in Central Sulawesi (Indonesia)	189

Determinants of Adoption and Intensity of Use of Balanced Nutrient Management Systems in Northern Guinea

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The balanced nutrient management systems (BNMS) project was introduced into the northern Guinea savannah of Nigeria (NGS) to assist poor farmers to cope with problems of dwindling soil fertility. The project began in 1997 and it involved testing of a technology package that includes the combined application of inorganic/organic fertiliser (BNMS-manure) and soybean-maize rotation (BNMS-rotation). Demonstration trials started in 2000 in the region.

This study employed Tobit regression model to examine factors that influence the adoption and intensity of utilisation of the soil enhancement technologies of BNMS project in the NGS of Nigeria. Empirical results showed that < 10 % of the sample households adopted at least one of the two components of the technology packages at the end of 2001, however, by 2004 the adoption of BNMS-rotation had reached 40 % while that of BNMS-manure had reached 50 %. A number of factors such as access to credit, farmers' perception of the state of land degradation, and assets ownership were found to be significant in determining farmers' adoption decisions on BNMS-manure while off-farm income was found to be significant in determining farmers' adoption decisions on BNMS-rotation. Tobit decomposition results showed that new adopters contributed to intensity of use more than existing adopters of BNMS-manure.

Results further showed that extension services, project activities of the International Institute of Tropical Agriculture, and farmer-to-farmer technology diffusion channels were the major means of transfer of BNMS technologies. Findings also showed that BNMS-manure occupied 35 % of the total maize land, BNMS-rotation covered 12 % of the total maize land, and inorganic fertiliser occupied about half of the total maize land in the study area of northern Guinea savannah of Nigeria.

Keywords: Balanced nutrient management systems, manure application, Nigeria, rotation, maize, soybean, inorganic fertiliser

The Role of Farmer Training in the Diffusion of Biotechnology in Cotton in China: A Multi-Period Analysis

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This paper applies a “difference in difference” model to analyse the combined medium term effect of the introduction of genetically modified cotton varieties and farmer training using the farmer field school approach. The model uses a combination of cross section and time series data to measure the direct and indirect (exposure) impact of farmer field schools (FFS) on major economic indicators such as yield and insecticide use. Particular emphasis is given to explore the interaction between farmer education and Bt-cotton. Data were collected from over 1000 farmer households in three provinces in China, namely Anhui, Hubei and Shandong with the first two representing the Changjiang Cotton Region and the last one representing the Yellow River Cotton Region.

The empirical results demonstrate significant impact of FFS on both yield increase and insecticide reduction for trained farmers. Those impacts developed shortly after the training took place and well sustained up to medium term. Substantial exposure effect on pesticide use is also identified in the short term but found to have diminished to some extent with the passage of time. No significant exposure effect on yield can be concluded in this case. Another informative finding is the favourable interaction between the farmer education and biotechnology. As an alternative to chemical pesticides, Bt-cotton per se is found to contribute to a modest reduction in insecticide use but no yield gains. When the FFS dimension was added to Bt-cotton cultivation, the substitution of engineered Bt-trait to agrochemicals was catalyzed. Furthermore, considerable productivity gains were achieved in the Bt-cotton plots managed by those farmers who ever undertook FFS education.

Keywords: Bt-cotton, China, DD model, Farmer Field School

Agricultural Technology and Information Response Initiative (ATIRI) in Kenya: Influence of Intrinsic Farmer-Group Characteristics on Household Adoption of Demand-Led Improved Agricultural Technologies

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The United Nations in 2000 renewed the commitment to human development through the declaration of Millennium Development Goals (MDGs). The target population for the eight goals is mainly the rural poor, whose principal economic activity, especially in Africa, is agriculture. This makes delivery and adoption of relevant and improved agricultural technologies for increased productivity and profitability, through innovative Research-Extension-Farmer linkages, critical to achieving the MDGs. However, Research-Extension-Farmer linkages in Kenya, as in most of Sub-Saharan Africa, require improvement. This paper examines the intrinsic group characteristics that influence adoption of improved agricultural technologies in a group-based demand-led approach; the Agricultural Technology and Information Response Initiative (ATIRI), used by the Kenya Agricultural Research Institute (KARI) to catalyze agricultural technology dissemination and adoption. To this end, 190 members out of a total of 494 members of 20 farmers' groups from Nakuru District, Kenya, who used the ATIRI approach between 2000 and 2002, were sampled. Data analysis focused on the following intrinsic group characteristics: a) motivation to join and remain within groups; b) characteristics of group leaders; c) inter- and intra-group networking and communication behaviour; and d) groups' organizational capabilities. Principal Component Analysis (PCA) using the Varimax rotation method with Kaiser Normalisation was used to extract principle underlying components from the factors describing each characteristic. The extracted components formed the basis for subsequent binary logistic regression analysis with adoption as the dependent variable. Significant and positive coefficients were realized for: 'regular change in leadership' ($p < 0.001$); 'group support to education and training' ($p < 0.05$); 'groups' capacity to provide agricultural inputs to members' ($p < 0.05$); and, 'information and advice from community leaders' ($p < 0.1$). The component 'leaders with professional skills' was significant ($p < 0.1$) but negative. These results suggest that, groups which change their leaders regularly are better organized to also support adoption decisions among members; education and training of group members and provision of agricultural inputs encourages adoption; and that the involvement of community leaders contributes to adoption of technologies. However, group leaders with professional skills do not necessarily serve farmers' groups well possibly because their commitment to the group is divided between the group and other professional engagements.

Keywords: Adoption role, agricultural technology, demand-led approaches, farmer groups,

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Adoption and Diffusion of Fish Ponds in Malawi

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In face of a growing world population and declining fish stocks through overfishing, aquaculture can play a key role through the provision of high value protein affordable to poor people in developing countries. This situation is particularly true for Malawi whose problems and promises of fish farming development are representative for sub-Saharan Africa. Yet, the full potential of fish farming is far from being realised in Malawi although enough suitable dambo land (wetland on flat plateaus) is available. The purpose of this study was twofold. Firstly, to identify perceived driving forces that lead to adoption of fish farming in earthen ponds in Malawi and inhibiting forces that hamper their sustainability and spread. Secondly, to compare farmers' situations in Malawi and Cameroon in view of the potential for future development of fish farming. Everett ROGERS' (2003) 'variables determining the rate of adoption' are used as analytical framework and a farmer typology is constructed based on Susann KLUGE (2000) and BARTHON and LAZARFELD (1955).

Semi-directive interviews with fish farmers for qualitative and quantitative data collection were used. General patterns of decision-making processes and important driving and inhibiting forces were determined. Interviews with local experts provided background knowledge, completed the picture and helped to critically reflect preliminary results.

The outcome is the understanding of fish farmers' perceptions and decision-making through the analysis of fish farming as an innovation taking into account i.e. its farmer-perceived attributes. Based on representative farmer cases, the relative advantage of fish farming will be considered with the comparison of gross margins of alternative dambo crops. The typology of fish farmers in selected areas of Malawi is used to explain the current development of fish farming from a sociological point of view. In addition, the latest official Malawian aquaculture statistics are analysed in a comprehensive and critical manner.

The results will be discussed in view of recommendations for future promotion strategies.

Keywords: Adoption rate, aquaculture, diffusion rate, driving and inhibiting forces, fish farming, Malawi, relative advantage

Implications of the New Land Law in Mozambique on Collective and Individual Ownership and Natural Resource Management

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The reform of the land law in Mozambique established new forms of land ownership, two are relevant to groups, associations or rural communities: (1) collective registration of land, i.e. a community/group registers former communal land and obtains a land title, (2) the continuation of traditional allocation of community land through the traditional leader. While the law considers both forms as equal in case of land disputes, practical implications for groups and communities vary significantly, especially from women. Though individual land titles have also been established under the new law, it is not practicable for rural households. Land ownership for smallholder farmers in Mozambique thus remains a complex issue of individual and collective entitlements. The aim of this paper is within the context of poverty reduction and secure access to land as a basis of livelihoods of smallholder farmers in Mozambique. Two case studies of Búzi district position the new land law within the contented theoretical debate on collective land ownership and assess in how far new forms of collective ownership are a chance to engage in collective action, and provide new opportunities of income generation for local people. However, long-term impacts of collective ownership in respect to potential exploitation and consequent to deterioration of natural resources are often disregarded.

The first case presents farmers associations who registered their land. As a group, members access new technologies which modify traditional practices of natural resource management (NRM).

The second case presents a rural community that has registered their land. One implication of obtaining a land title is to be entitled to 20 % of the taxes that the government imposes on external actors that exploit natural resources, such as wood or forest products, from the region that is under the title of the community.

Legalizing land of groups and communities is often supported and financed through development projects. In areas of scattered settlement patterns social relations are based on kinship ties. Group and community development processes are important to consider to ensure equitable, sustainable and socially acceptable development outcomes.

Keywords: Communities, gender, Mozambique, natural resource management, collective ownership

Assessment of Past and Present Soil Conservation Initiatives in Nigeria, West Africa

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Non-adapted land use practices as well as the lack of inputs inevitably lead to soil degradation that has already become the most critical environmental problem in Sub-Saharan Africa. Consequences are reduced soil quality and productivity resulting in declining crop yields and lower income of the rural population. There is an urgent need to develop effective soil resource managements that reverse the degradation trend in order to sustain soil productivity and enhance food security. Research on soil erosion and conservation has already been done for many years in different parts of West Africa including Nigeria. But in view of increasing soil degradation, there is a need to review existing soil conservation practices and come up with comprehensive soil conservation strategies for the West African savannah. Earlier initiatives have resulted in a range of on-farm and off-farm technologies. However, no information is available on their efficiency, their adoption and perception by farmers as well as on their costs and benefits.

This assessment study started in 2006 to identify current initiatives and their effectiveness including sociological, technological, and economical aspects. An extensive literature review was conducted including scientific (universities, ministries, non governmental organisations) and digital resources to get information about past and present research and performance of soil conservation in Nigeria. Furthermore, pilot villages where different types of conservation technologies were/are installed in the field were visited and interviews with stakeholders and farmers were made in order to study the adoption of conservation technologies (adoption barriers, adaptation to the initiatives, and perceptions of impact). Based on the results, the most promising soil conservation technologies for the savannah are identified contributing to an enhanced soil resources management in Nigeria.

Keywords: Adoption, assessment, Nigeria, soil conservation, sub-saharan Africa

Demand Estimation of Subsistent Farm Households in the Dry Land of the Sudan: Almost Ideal Demand System Approach

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It is found to be stubborn in the case of developing countries to estimate demand functions because of unavailability of reliable time series data. As a consequence of extensive household cross-sectional surveys, many academic persons estimated expenditure elasticities and disregarded the price elasticities. Undoubtedly, results from such partial analysis might not be very dependable for development policy planning. This paper presents estimates of the almost ideal demand system (AIDS) for bundle of consumed goods by farm household in western Sudan, to investigate the effect of prices as well as household characteristics on their consumption patterns. Primary data were collected from 139 farm households by means of structural questionnaire. Using data on expenditure shares and prices, a Seemingly Unrelated Regression (SUR) was used to estimate the model for the total surveyed sample as well as for three categories of farm household on the basis of farm size. However, variables other than income and prices like aggregate household size, location, age and education level of the household head, were found to have important roles in determining the consumption patterns. Two-stage budgeting and separability procedure was applied to the total expenditure allocation. Six food commodities were considered for running the AIDS. Compensated and uncompensated own and cross price elasticities were calculated by using the estimated parameters. The study results revealed a significant negative influence of the family size on expenditure allocated to health, clothing and education. Moreover, the calculated expenditure (income) elasticities showed that clothing, health and education were found to be luxury good and services. On the other hand, an income increase showed a negative effect on food expenditure, whilst positively influenced expenditure on health, education and clothing. To conclude, results from this study have confirmed that the smallholder households have the highest budget share of food in total expenditure among the different three farmer categories and the big share went for cereal and edible oil.

Keywords: Dyland, household demand, western Sudan

Impact Pathways Assessment of Research for Development Programme: A Dual Purpose Cowpea Breeding Programme of the International Institute of Tropical Agriculture in Northern Nigeria

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The primary focus of agricultural research and extension in Africa is technology generation and dissemination. Despite prior critiques of the shortcomings of this approach, the consequences of such activities continue to be measured through the number of technologies developed and introduced into the supply chain. Impact assessments of these programmes have taken various forms from simple to complex, and may involve inputs from different disciplines. Where impact assessment was carried out on the livelihood outcomes of farming communities; such approaches have focused on the total number of adopters and by the household and system factors influencing adoption. In addition to this, quantitative estimates of varietal adoption rates, economic value of crops and livestock are used. On occasions this work has been broadened to look at wealth, income distribution and other social outcomes of research activities. However, there has been comparatively little analysis of the processes and pathways that gave rise to these outcomes despite the importance in understanding the pathways of different types of agricultural technologies on poverty reduction and natural resource use. For example when high economic rates of return are estimated, there is often no serious analysis to understand why on occasions research gives rise to high rates of return and other occasions to low rates of return.

Conventional impact studies are able to document the improved seed technologies; however where agricultural programs have combined this with knowledge systems such as soil conservation practices, input management, natural resource management, it becomes harder to track adoption barriers and attribute impact. Examining impacts processes and impact pathways of different types of agricultural technologies can guide future research in ways that will make the greatest contribution to poverty reduction. If technological innovation is seen as a discrete step - introducing new technologies rather than process substantial risks may also be introduced into the system through socio-economic gap-widening or decreased agroecosystem resilience. This paper seeks to use a case research in northern Nigeria to understand impact process and pathways of international research for development projects on poor small holder farmers.

Keywords: Impact assessment, international research, natural resource management, poverty reduction, sustainable livelihoods, cowpea breeding

Technology Adoption in Aquaculture in Developing Countries: Genetically Improved Tilapia in the Philippines

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Freshwater aquaculture is becoming more important as a source of food and income, especially for small-scale producers in developing countries. One of the most common freshwater species is tilapia (*Oreochromis niloticus*) that originates from Africa but was introduced into many Asian countries in the 1970's. Tilapia can be produced with low costs and under low input management. However, cultivated tilapia fish were commonly small and hence yields and returns are low. This was mainly attributed to poor genetic status of farmed tilapia stocks because of poor broodstock management ensuing inbreeding and introgression of undesirable genes. To increase profitability, a selective breeding effort coordinated by the WorldFish Center started in 1988 under the Genetically Improved Farmed Tilapia (GIFT) project in the Philippines. This paper analyses the response to the resulting GIFT strain (improved variety) among cage culture operator in several lakes in the Philippines. The research is an adoption study that goes beyond the conventional adopter versus non-adopter paradigm. We interviewed 300 tilapia operators in late 2006 in the provinces Laguna and Batangas. Adoption is modeled as a dynamic and recursive process where adoption, dis-adoption and re-adoption can occur in the context of a rapidly changing institutional environment including the emergence of new technology suppliers. The models facilitate the identification of impeding and stimulating factors of GIFT adoption. Results show that first time adoption and adoption intensity are driven by similar factors. These include the size of the operation, location factors, information exchange as well as experiences with alternative technology. The decision about cage area allocation to GIFT is adversely influenced by experiences with tilapia production and scale of operation. In addition, training and external source of fingerlings other than own hatchery strengthen the decision to retain the technology. The paper shows that unlike in agriculture where technology supply systems are well established, the lower level of regulation in aquaculture technology development at the national level may lead to inefficiency of technology supply and high levels of uncertainty.

Keywords: Adoption models, aquaculture, Philippines, tilapia

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Effects of the Interaction of Migration, Financial and Social Capital on the Adoption of Agricultural Innovation and on Social Stratification in Central Sulawesi (Indonesia)

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The adoption of cacao agroforestry in mountainous Central Sulawesi is a key process for poverty alleviation at the community level with ambivalent social effects. Furthermore, cacao agroforestry expansion leads to deforestation of uplands at and beyond the border of Lore Lindu National Park (LLNP), one of a few little-disturbed core areas of the Wallacea biodiversity hotspot. We knew from previous studies that Buginese migrants acquire land around LLNP predominantly via purchase while autochthonous households acquire land mainly by forest conversion. We argue that the adoption of intensive agroforestry systems results in deforestation and social stratification via an iteration of financial capital- and personal capital-driven land acquisition and agroforestry intensification by Buginese migrants, and social-capital and poverty-driven forest conversion by other inhabitants. We test this hypothesis using census data of 787 households (2005) from three contrasting villages (Chi²-Tests).

At the inter-village level, Bulili—a village in the agronomically more valuable, more flat Palolo Valley- has the highest percentage of Buginese inhabitants (43.7 % vs. 14.9 % and 0.6 %), the most intensive cacao production (e.g., only 1.7 % extensive ‘forest cacao’ vs. 7.4 % and 15.4 %), and on average the best-off inhabitants ($p = 0.002$). In general, Buginese migrants occupy the better, more flat land (often at or near valley bottoms) while other inhabitants possess, on average, more steep uplands ($p < 0.001$). This is the result of the Buginese quest for high value land outside mountainous LLNP. The Buginese stem from economically more advanced southern Sulawesi where intensive cocoa production is well-known. Migrants of other ethnicity lacking this background do not possess more flat land (all migrants: $p = 0.148$). Locals are willing to sell their land including extensive cacao plots because they command the social capital to convert forested uplands even inside LLNP. In contrast, Buginese moving to intensified, petty capitalist-type surplus production are rarely in need to sell land. Facilitated by lacking knowledge on intensified cacao agroforestry, and because proceeds from land sales are often used for culturally mandated status consumption, a creeping spatial and economic marginalisation of the non-Buginese inhabitants is observed: Predominantly, poorer, non-Buginese households are found on the steeper uplands ($p < 0.001$).

Keywords: Cacao agroforestry, cultural factors, ethnicity, marginalisation, migration, national park, poverty alleviation, social stratification, uplands

Sustainable development in practice - examples from GTZ's projects

Oral Presentations	192
CHRISTOPH KOHLMEYER, KARIN FOLJANTY: What Means Sustainable Development for German Development Cooperation?	192
MATHIAS BRAUN, CHARLOTTE HAEUSLER, LEA HERBERG: SUSTAINET - Networking for Sustainable Agriculture to Combat Hunger	193
PIER PAOLO FICARELLI: Seed of Hope for Rural South Africa: Bringing Innovations to Communities and Institutions	194
FERNANDO GAST, HERBERT FRÖMBERG: Biodiversity and Development in Strategic Colombian Eco-Regions - The Colombian Orinoco Region	195
JOERG AMEND, TOBIAS STOLZ, IDOWU AJIBOLU: Margarine from the Rain Forest — Income Generation through a New Non Timber Forest Product	196

What Means Sustainable Development for German Development Cooperation?

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Since the 1992 Earth Summit in Rio de Janeiro in particular, the term “sustainability” has been an omnipresent buzzword. It has in fact become the guiding vision of national and international politics. German development cooperation works at three levels to attain the goal of sustainable development: internationally, together with the partner countries and within Germany.

International agreements help create the framework for efforts to protect the environment and make sustainable use of resources. Within partner countries, German development cooperation support concrete activities to protect the environment and share natural resources more equitably. And in Germany, awareness-raising activities improve public understanding of the relationship between development and environmental protection.

For practical development cooperation, sustainable development means:

- supporting sustainable economic growth in partner countries, in order to alleviate poverty and disparity (pro poor growth);
- ensuring equality of opportunity, between rich and poor, North and South, women and men;
- utilising natural resources for the benefit of humanity today such that they are preserved for future generations.

Sustainable solutions to complex development questions are not available off the rack. This is why a mix of different types of interventions is used, including policy advisory services, technical and organisational consultancy, and financing. German development cooperation operates at government level, and also cooperates with civil society, private sector, the local population and other bilateral and international donors.

Keywords: Earth summit, German development cooperation, pro poor growth, sustainable development

SUSTAINET - Networking for Sustainable Agriculture to Combat Hunger

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“SUSTAINET - Sustainable Agriculture Information Network” aims to systematically evaluate, communicate and disseminate successful approaches and concepts of sustainable agriculture in selected pilot regions.

In developing countries, 75 % of the poor live in rural areas. Agriculture is their main source of income. For the purpose of poverty reduction, agriculture is therefore pivotal. SUSTAINET has identified sustainable examples of good agricultural practices which are capable of bringing about a lasting reduction in rural poverty, and which have the potential for scaling up.

The goals of SUSTAINET are to demonstrate the importance of sustainable agriculture for poverty reduction and global food security; to scale up promising pilot approaches and ensure that they no longer remain one-off solutions; and to engage in political lobbying in order to establish firm foundations and enabling conditions in the national context.

SUSTAINET networks have been established among institutions at local, regional and international level. SUSTAINET is composed of a German network and three further networks in the pilot regions of India, Kenya/Tanzania and Peru/Bolivia.

In Germany, members of the network include both state institutions (the German Federal Ministry of Food, Agriculture and Consumer Protection (BMELV), the Federal Ministry for Economic Cooperation and Development (BMZ), Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) and the German Council for Sustainable Development) and non-governmental organisations (Brot für die Welt, Deutsche Welthungerhilfe and Misereor).

As a first step, the network selected examples of good practices in sustainable agriculture. Its local partners evaluated the pilot projects using a self-assessment tool developed in the course of SUSTAINET. They wrote up their success stories during a Sustainet-Writershop. The results have then been published in a book series: Sustainable Agriculture - A pathway out of poverty for the rural poor (available at: www.sustainet.org).

Furthermore an analysis matrix to assess the scaling up potential of the selected good agricultural practices was developed.

Through SUSTAINET local and international communication structures and networks have been established. These are the basis for the active exchange and strategy dialogue with key actors based in the partner countries or involved in German and international development cooperation.

Keywords: Good agricultural practices, network, poverty reduction, scaling up, sustainable agriculture

Seed of Hope for Rural South Africa: Bringing Innovations to Communities and Institutions

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Ten years after the end of the Apartheid regime, large part of the black South African population still lives in utter poverty. The rural-urban divide mirrors the dualistic nature of the South African economy, which underpins the structural cause of poverty in rural areas.

Between 1997 and 2006, GTZ together with the South African Government in the Limpopo Province has institutionalised Participatory Development Approaches (PDA) to better respond to the economic and social development needs of impoverished communities. The project has focused on the development of models for agro-based economic development, matching the availability of local resources, building on social capital and strengthening local organisational capacity and representation.

A range of social and technical innovations were introduced to rural communities and institutions. This was achieved through developing competencies of people, expanding service capabilities of organisations and setting new policies in institutions. The project is an example of Capacity Development, the methodological thread that distinguishes GTZ work in international co-operation.

Project interventions have facilitated change at the interface of communities and service providers, a pillar in any client-oriented service delivery system. This was realised by taking different stakeholders from research, private sector and civil society in “round tables”. Through new service platforms agricultural innovations from research benefited farmers. A PPP model and market linkages facilitated the commercialisation of local produce to bring concrete economic improvements to farmers.

Visible results have been obtained. 300 field extension officers were trained over a period of 2 years through a learnership. More than 1000 community self-help groups have become more effective through the establishment of co-ordination bodies at village level. The Limpopo Smallholder Farmer Association represents the interests of smallholder farmers and partners with the Department of Agriculture in service delivery. Today, more than 1000 smallholders produce certified seeds and market them through a co-operative. Other innovations in basic animal health, soil fertility management and conservation farming were also successfully disseminated.

Ownership of the required organisational changes was anchored into the Departmental organisational systems. This has allowed the learning made in Limpopo to be replicated in other provinces of South Africa.

Keywords: Capacity development, community-based seed provision, demand-led service delivery, agricultural innovation system, local organisational development, participatory development approaches, South Africa

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Biodiversity and Development in Strategic Colombian Eco-Regions - The Colombian Orinoco Region

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As a response to the imminent degradation of biological resources in the Colombian Orinoco region, the Alexander von Humboldt Institute of Biological Research (IAvH) with the support of the German Cooperation Agency (GTZ) and other international, national and regional agencies started the Orinoco project in 1997. The projects objective is to foster knowledge, sustainable use and conservation of biodiversity in the Orinoco region, through the design and execution of a Regional Plan of Action in Biodiversity.

The study area of the Orinoco Region Project encompasses the Orinoco River watershed on the Colombian side, that comprehends approximately 347.000 km² comprising a diversity of landscapes, ecosystems, species and human groups. This region hosts 600 species of birds, about 200 mammals, and a large water reservoir, considering that about 30 % of the Colombian water springs and runs in the Orinoco region.

In this initiative, governmental and non-governmental institutions participated in the table, such as the regional environmental authorities (Corporinoquia and Cormacarena), the University of the Llanos (Unillanos), The American Tropics International Foundation (Unitripico), Javeriana University, the Omacha Foundation, the Green Horizon Foundation, the World Wildlife Fund-Colombia, GTZ. The coordination was bestowed by Humboldt Institute.

During the five years of the projects execution, significant advances were achieved. The main accomplishment was the formulation of a Regional Plan of Action on Biodiversity for the Colombian Orinoco region watershed for 2005–2015, as a navigation map for the management of biodiversity in the region. Additionally, the project renders an important breakthrough in magnifying, systematizing, and diffusing knowledge about the Orinoco region through the design and implementation of information tools, biological and production systems characterisations, the use of biodiversity by local communities, the increase and strengthening of biological collections including the sounds and tissues bank and the implementation of a regional information system on biodiversity. Commercialisation activities for the promotion of biodiversity goods and services were performed with local communities and the analysis of policies and biodiversity valuation took place.

Finally, around the regional project and the strengthening of institutions and local population in the acknowledgment of biological resources, concrete contributions to human well being are in place.

Keywords: Biodiversity, biological collections, local communities, Orinoco

Margarine from the Rain Forest — Income Generation through a New Non Timber Forest Product

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Allanblackia floribunda is a tree thriving in the rain forests of West Africa. The seeds contain valuable oils which can be used as raw material in margarine production and other food related processes. So far the seeds and the timber are hardly used thus income from the collection of seeds could supplement household income of rural farmers. Alternative sources of income are scarce for them and the limited range of agricultural crops produced make them very dependent from seasonality and marketing agents.

The common procedure for land clearing before the season is still slashing the undergrowth, cutting trees indiscriminately and burning. Introducing a non timber forest product (NTFP) and therefore giving the *Allanblackia* tree a value might open new income possibilities and the potential for increased sustainability through the integration of this tree into existing farming systems.

A public-private-partnership (PPP) between the German Technical Cooperation (GTZ) and the two multinational companies Unilever and Shell support the establishment of a sustainable supply chain for the NTFP *Allanblackia* seeds in Nigeria.

Unilever guarantees the purchase of all seeds delivered at a preset price. GTZ mobilises potential seed collectors and helps them develop to become competent business partners for the Unilever purchasing structure and adhere to social, ecological and quality criteria.

In 2005 an *Allanblackia* tree inventory was carried out in Edo State. In a pilot phase 50 communities were selected in early 2006, potential collectors trained and a purchasing structure established.

Conflicting messages about farm gate prices kept motivation low and only little produce was delivered to the collection points.

For the upcoming 2007 season prices are adjusted and increased by more than 60%. Operations will be extended to 3 more states and more than 300 communities in total. First results will be available by mid 2007.

Keywords: *Allanblackia*, income generation, Nigeria, NTFP, PPP

Research for development practitioners

Oral Presentations	199
DIDIER PILLOT: Is Agriculture Coming Back to the Front of the Stage? An Analysis of the Recent Evolution of the Mainstream Thinking	199
ERMIAS HABTE: The Developmental Effect of Food Aid, with a Special Inference to Social Capital: A Comparative Study of Food Aid Recipient and Non-Recipient Villages in Northern Ethiopia	200
DIETMAR STOIAN, JASON DONOVAN: Value Chain Development from a Livelihoods Perspective: A Multi-Chain Approach for Coffee and Cacao Producing Households in Central America	201
Posters	202
PETER LUSEMBO, AHMED KYAMBADDE-KYEYUNE, HEINZ LOOS: Contests as a Tool to Enhance Farmer Innovativeness and Sharing of Information for Sustainable Farming: A Case for Uganda	202
SAMUEL MUHUNYU, SAHLE TESFAI: NECOFA Kenya Initiative to Inculcate Positive Attitudes in the Youth Towards Sustainable Management of Food, Agriculture and Environment	203
HTUT YIN MIN, JÜRGEN PRETZSCH: An Analysis of Collective Action in Forest Plantation Establishment by Forest User Groups	204
PIYATAT PANANURAK, SUWANNA PRANEETVATAKUL, HERMANN WAIBEL: What Can we Learn from Country Comparisons of Investment in Farmer Education? The Case of Farmer Field Schools in Cotton in China, Pakistan and India	205
MARCO OTTO, FRANK BLUME, THOMAS NEHLS: Conservation of Peruvian Terraces through Intensification and Diversification - The Role of German Students in the Process	206

KENDRA LEEK, MICHAEL HAUSER, DOUGLAS WHITE: Wealth, Livelihood Transitions and Poverty in Northern Lao, PDR. Why Targeted Development Interventions are Needed	207
BEATRICE NOWOTNICK: Participatory Research and Land Use Management in the At- lantic Rainforest Biosphere Reserve: The Case of the Tobacco Farmers in Atalanta - Santa Catarina - Brazil	208
CORINNE VALDIVIA, ROBERTO QUIROZ, FRANK SPERLING, ROBERTO VALDIVIA, LENKIZZA ANGULO, DIANA SIETZ: Climate Vulnerability, Local Knowledge and Adaptation to Climate Impacts in Peru	209

Is Agriculture Coming Back to the Front of the Stage? An Analysis of the Recent Evolution of the Mainstream Thinking

DIDIER PILLOT

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The Developmental Effect of Food Aid, with a Special Inference to Social Capital: A Comparative Study of Food Aid Recipient and Non-Recipient Villages in Northern Ethiopia

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In today's world close to 800 million people live in a state of hunger. In the MDG's, boosting external aid is one of the major incentives made available by donors. However aid effectiveness has been in the spotlight for several reasons. Despite a decreasing trend at the global level, food aid continues to be a significant component of development assistance to Ethiopia.

Food aid provision aims at either consumption smoothening or as a long-term developmental resource in food for work (FFW) activities. The normative argument is that participation in FFW enhances the capital stock of households by rebuilding their asset in the aftermath of production shock and (when pre-emptive arrangements are made) food aid provision guards households from depleting their productive asset. Nevertheless, this study argues that food aid does not similarly affect all aspects of capital stock. The research particularly attempts to gauge the unintended effects of food aid on social capital by making comparative analysis between food aid recipient and non recipient villages. Social capital, defined by the networks and norms, determines an essential component of society's capacity to positively interact and collectively change their living environment. There is a growing consensus that high level of social capital transforms into functional capital.

The research draws information from a structured survey in 175 rural households of selected villages in northern Ethiopia and several focus group discussions held with leaders of formal and informal institutions. Preliminary results indicate that long-term food aid recipient households are endowed with less social capital compared with their non-food aid receiving counterparts. While both village experience similar levels of network type and density, in specific measures, the non-recipients are socially better interactive, less conflictive and exhibit higher group and personal trust. Besides, non-recipient households are also more resilient to production and consumption shocks in difficult times. The empirical work is indicative of the need to have a second look at food aid policy in general and its operational programming in particular. A possible way forward could be empowering the traditionally existing networks to play more roles in food aid targeting and delivery activities.

Keywords: Ethiopia, food aid, social capital

Value Chain Development from a Livelihoods Perspective: A Multi-Chain Approach for Coffee and Cacao Producing Households in Central America

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Over the past years, approaches to value chain development have increasingly been advocated by research and development institutions worldwide. It is argued that the integration of smallholders and their business organisations in value chains holds the potential to generate additional employment and income and hence reduce rural poverty. Recently, however, there has been growing concern that value chain development may not reach the poorest of the poor, or fully deliver the expected results in those cases where they have been directly involved. In this paper we argue that effective pro-poor value chain development requires the adoption of a livelihoods perspective. Based on examples from coffee and cacao producing households in Belize, Guatemala, Honduras, Nicaragua, Costa Rica and Panama we show that virtually all of them pursue diversified livelihood strategies by combining subsistence with market-oriented agriculture and carefully balancing on-farm with off-farm income sources. Coffee and cacao are important, though not necessarily the principal sources of income. Rather, coffee and cacao related activities relate to diverse agroforestry systems that yield a number of products and services geared towards subsistence and the market. Value chain development approaches focusing exclusively on coffee or cacao usually fail to account for diverse livelihood activities and may require disproportionately high investments of family labour and financial resources in the related production systems. We propose a multi-chain approach to supply and value chain development that helps elucidating the involvement of the rural poor in multiple livelihood activities and identifying opportunities in related supply or value chains. Our analysis reveals that though there are opportunities for developing coffee and cacao value chains, there are also a number of “secondary” chains (e.g., beans, maize, fruits and horticultural products) that deserve investment. Careful analysis of the diverse options and the respective trade-offs at household and community levels help tailoring the design of interventions that lead to more inclusive development. For Central American coffee and cocoa producers we propose moderate interventions in “secondary” supply chains, in addition to major interventions in the coffee and cacao chains, with the aim of increasing livelihood security and reducing poverty among rural smallholders.

Keywords: Cacao, Central America, coffee, livelihoods perspective, multi-chain approach, supply chain, trade-off analysis, value chain

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Contests as a Tool to Enhance Farmer Innovativeness and Sharing of Information for Sustainable Farming: A Case for Uganda

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A farmer contest was organised among 23 Farmer Research Groups (FRGs) during implementation of a pilot project on Integrated Rural Resource Management (IRRM) in Central Uganda. The FRGs were made up of 135 and 186 farmers from sub-counties of Kayonza and Wakisi, respectively. The major objective of the contest was to foster farmer innovativeness in water harvesting techniques, soil and water management and facilitate exchange of knowledge and information among farmers. During planning, key stakeholders (farmers, NGOs, opinion leaders, extension agents and researchers) brainstormed to develop the contest theme, guidelines, criteria for judgment and prizes. The agreed theme was Sustainable Farming Practices and Innovations for optimum Productivity While Conserving the Natural Resource Base. Evaluation was at three levels. First, FRGs (most of which had 10–16 members) identified the best three farmers, using their own criteria. In phase two, sub-county Evaluation Committees were elected and sensitized to develop criteria to screen out the best 10 performing farmers from each of the sub-county. During phase three, the Project Contest Evaluation Committee (composed of all the stakeholder representatives) was instituted to make final contest judgment and award prizes. During the contest process innovations were identified and farmers showed that they could engage in productive agriculture using readily available resources. Given the innovativeness exhibited in soil and water management practices by participating farmers, it was evident that under proper guidance farmers can enhance sustainable agricultural production with minimum external inputs. The three-level evaluation of the contest facilitated exchange of knowledge, as farmers visited fields far from their areas of operation. The final day of the contests attracted a cross section of the communities and enabled farmers and other stakeholders to exchange knowledge and learn from one another. The enthusiasm shown by many observers including political leadership pointed to fact that contests can be a tool for enhancing farmer innovativeness in sustainable agricultural production, including organic farming. It was concluded that contests are an alternative avenue through which knowledge, farm practices and technologies can be shared among farmers.

Keywords: Evaluation, farming systems, soil management, water management

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NECOFA Kenya Initiative to Inculcate Positive Attitudes in the Youth Towards Sustainable Management of Food, Agriculture and Environment

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Network for Ecofarming in Africa (NECOFA) is a community based NGO promoting Eco-farming: Ecologically and Socially Sustainable Land Management. NECOFA is committed to empowering communities to rediscover themselves; to scale up and out positive values of sustainable development that is based on minimum external inputs and rich social-cultural heritage. NECOFA is supported by Capacity Building International (InWEnt) of Germany.

To achieve sustainable development, it is important to invest and integrate the youth in development activities. The current generation is utilising and managing the environment and biodiversity on “lease” from future generations. It is therefore important to equip young people with knowledge and skills for sustainable management and utilisation of food, agriculture and the environment.

The NECOFA Kenya initiative in this regard involves school gardens and is being piloted in 2 primary schools (Michinda and Mukunyi) in Molo district.

Project objectives :

- i. To influence and enhance interests and concern for “good,” “fair” and “clean” food in the growing youth.
- ii. To provide hands-on experience for the youth in food production and conservation of the environment.
- iii. To provide the youth with a platform for sharing/accessing information with others locally and internationally.
- iv. To multiply (bulk) planting materials in the schools for neighbouring communities thereby strengthening collaboration/partnership between schools and the community.
- v. The school garden projects become learning/demonstration centres for the community and other school youth.

To make the initiative enjoyable and interesting for the youth, the project has additional activities for the school club members i.e. the game of tenniquoit; exchange visits; newsletter and access to computer/internet.

The youth have shown great enthusiasm in this project and have trained fellow students, teachers and parents. They have also made presentations/exhibitions during public forums -food fairs, field days and agricultural shows. The schools are demonstration centres and source of planting materials e.g. trees seedlings for the community. The initiative is being replicated in other schools in the district and beyond.

Keywords: Ecofarming, school project

An Analysis of Collective Action in Forest Plantation Establishment by Forest User Groups

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The research target is to describe and analyse critically the Community Forestry Projects in Myanmar. Community Forestry Instruction (CFI) was issued by Forest Department in 1995. The major aim is to promote the community initiative reforestation and conservation at the local level. The Forest Department and NGOs have been trying to assist the targeted communities to establish the forest plantations in the dry zone of Myanmar. The local people formed Forest User Groups and established the forest plantation in accordance to CFI. The rehabilitation of marginal land through community based forest plantation is valuable for local people. The members receive the forest products for their subsistence economy while agricultural production has been diminishing under a long run land degradation process. The major issues are strengthening of FUGs and to obtain secure property rights from the local government.

Strong institutional arrangements are one of the basic factors for successful community based forest plantation establishment. Within the context of institutional arrangements, the research focuses at the motivational factors of the members. The members contribute their time, labour and materials to the forest plantation establishment. The contribution to the forest plantation and decision making arrangements are different by wealth strata within the FUGs. After establishment the forest plantation, the members receive the products from their communal forest and share within the members. The research investigates the economic and political equity by wealth strata within the FUGs. Equity plays key role for the establishment of the community based forest plantation and it facilitates to the financial efficiency and sustainability of forest plantation in the dry zone of Myanmar.

Keywords: Community Forestry Instruction, decision making, Forest User Group, property rights, sustainability

What Can we Learn from Country Comparisons of Investment in Farmer Education? The Case of Farmer Field Schools in Cotton in China, Pakistan and India

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In this paper we present the results of the multi-country analysis of the impact of farmer training on the productivity of cotton and the in China, India and Pakistan. Data were collected under a project-specific impact assessment scheme which included a baseline survey in pilot areas and an impact survey in the year after the training, i.e. the first year that the training participants were able to apply their new knowledge and practices in their own fields. Hence the measured impact can be considered as conservative as the learning and practice change effect would develop over time.

Since panel data were available the methodology developed to assess training impact was a single period “difference in difference” model. Dependent variables included in the models were pesticide cost, yield, gross margin, and environmental effects using the environmental impact quotient (EIQ).

Results show that there are considerable differences in the effect of training among the three countries. Generally the productivity effects are higher in countries with lower yields such as for example in Pakistan. The major influencing variables are training quality and the initial level of farmer education. The results suggest that investment in farmer education can be efficient if the target population is well chosen and quality can be assured.

Keywords: Cotton, environmental impact, impact assessment, IPM, productivity

Conservation of Peruvian Terraces through Intensification and Diversification - The Role of German Students in the Process

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Peru is widely known for its impressive terraced landscapes built by ancient cultures like the Inka. Laraos, 100 km southeast of Lima, situated at 3500 meters a.s.l. is one of very few sites where people still use terraces as their ancestors did for centuries. Throughout history the community established a complex social system of sharing hard work, scarce water resources and harvest. Like elsewhere, this unique system is endangered due to globalisation. The main threat to conservation and sustainable use of the terraces in Laraos is migration due to low income of agricultural work. Subsistence farming based on potato and corn became less lucrative to young local population. As a consequence, the population dropped dramatically and 20 % of the terraces already vanished due to eroded irrigation systems or terrace walls.

The “Laraohuinos” together with a student group from Berlin and Lima, worked on strategies to preserve the terraces which have an economic and intrinsic value. Together with the farmers, main threats to the terrace system and actions needed to address them were investigated. Participatory methods based on theatre, work shops, and interviews were used by the students. Especially the theatre plays on legends encouraged public discussion. Threats and strategies to confront them could be named, hierarchal ordered and communicated (e.g. to emigrants in Lima). The “Laraohuinos” discussed solutions in workshops on land tenure, water distribution and irrigation and on diversification of products. As a result, concrete actions have been taken in the agenda of the municipality.

With the help of external students the public could be sensitized and motivated. Thereby the students acted as initiators and participants at the same time. As a not materialistic interested party they were accepted in the whole process as moderators and as questioners because of still being students. This position allows students to play a perfect facilitator role in the participation processes. Furthermore, because of the high number of students communication became an intensive group dynamic process.

Keywords: Agro-biodiversity, Andes, migration, participation, Peru, students, terraces, theatre

Wealth, Livelihood Transitions and Poverty in Northern Lao, PDR. Why Targeted Development Interventions are Needed

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Rural communities in northern Lao PDR are highly dependent on natural resources such as land, soils, water and forests for income and subsistence living. This is particularly true for the uplands where high rural population densities and poverty rates prevail. Numerous factors, including population growth, new market opportunities, and the implementation of government policies on land use, are changing rural people's access to natural resources. Against this background, research was undertaken to examine how livelihood strategies have changed between different wealth categories and in relation to resources access. In 2006, focus group sessions and semi-structured interviews were conducted in a case study village in Oudomxay Province. Results show significant changes in livelihood strategies and associated land uses over the last 10 years. The cultivation of upland rice and the raising of livestock, although still important, have decreased; while strategies such as the cultivation of lowland rice, sesame and maize have emerged and increased. Other strategies have also become more important, such as the cultivation of puak muak, paper mulberry (posa) and rubber trees. The density of puak muak and posa trees have decreased within the forest but increased on domesticated plots. There are adoption disparities of certain livelihood strategies between wealth categories. For example, people within the richest wealth category tend to cultivate more lowland rice and were the first to adopt this strategy. In addition, the access to certain natural resources also differs between wealth categories. For example, the majority of the agricultural land of the richest wealth category is located closer than that of the other wealth categories. Changes in access to natural resources have also occurred such as land is acquired differently due to the implementation of land allocation policies enforced by national and local governments. To address the priorities and capacities of families within different wealth categories, targeted development interventions are required that support livelihood transitions.

Keywords: Lao PDR , livelihood strategies, natural resources, poverty

Participatory Research and Land Use Management in the Atlantic Rainforest Biosphere Reserve: The Case of the Tobacco Farmers in Atalanta - Santa Catarina - Brazil

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Brazil is the world's largest tobacco leaf exporter and the second biggest producer. Almost all of it is grown in the south of Brazil, including the state of Santa Catarina (SC). There, tobacco farming has established itself as the main "cash crop" of predominantly small-scale, family-run farms that are part of an integrated production system. This has been associated with land degradation, poverty and health problems. Although Brazil has enacted stringent environmental regulations, enforcement is extremely difficult because of the large number of tobacco farmers contributing to deforestation. The uncontrolled cutting down of native wood to cure tobacco is the major cause for man-induced land degradation in the region.

This study was carried out within the framework of reforestation activities performed, in Atalanta (SC), by APREMAVI, a local NGO promoting forest conservation by fostering alternative forms of land-use for rural landowners. Current land use management practices as well as farmers' living conditions were investigated in-depth. Socio-economic problems were assumed to be the fundamental root of environmental degradation. Therefore, emphasis was given to integrating social science components into research on land-use management in order to understand the social dynamics that underlie the process of degradation.

The study demonstrates that successful reforestation and land-use changes on private properties rely on active involvement of the beneficiaries in each step of the process. A dialogue between farmers, practitioners and environmental scientists in which the participants' problems, views, expectations, and fears are expressed is imperative.

Through this approach, a process of reciprocal trust, respect and learning set in motion farmers' self-critique and rethinking concerning the use and protection of private land in the Atlantic Rainforest. The main achievements of this work were the changes in attitudes of farmers that are prerequisites for a movement towards better socio-economic and environmental conditions. Final recommendations on further research and suggestions for improving land-use management on the local level in the Atlantic Rainforest Biosphere Reserve are provided.

Keywords: Atlantic Rainforest, communication, land use management, participation, reforestation, tobacco cultivation

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Climate Vulnerability, Local Knowledge and Adaptation to Climate Impacts in Peru

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In the face of global change, development progress in Peru is significantly influenced by the high climate vulnerability. Thereby, climate conditions in northern Peru are dominantly influenced by El Niño, while in the Peruvian Altiplano El Niño effects are superimposed on the highly variable climate. In the context of rural development, community assessments delivered important insights on diverse local climate knowledge and adaptation options. Communities in Northern Peru mainly associate climate risks with major El Niño events, while in contrast communities in the Altiplano relate El Niño events largely to the northern Peruvian coast; not to their own situation.

The ability to cope with climatic hazards depends on livelihood assets and the ability to diversify income sources. Particularly in the Altiplano, the possession of livestock is an important coping strategy, since credits are difficult to access and monetary resources are limited. Communal support systems and share cropping also play an important role in reducing climate vulnerability. Assessments with community members led them to identify strategies they could develop on their own, and strategies that would require outside support.

In order to improve rural livelihood conditions, climate risk management can play an essential role. For example, climate forecasts have the potential to support communities' decision making in improving their agricultural production. However, current communication formats are limited as they are not well integrated into the local knowledge networks and decision-making processes. In order to be successful, the local understanding of El Niño effects needs to be better taken into account. Furthermore, climate information systems should reflect the interest of the communities in learning more about their disaster risks and strengthening early warning capabilities for floods, droughts and other hazards, which in the case of the Andes requires focusing on local scale forecasts.

Climate change is altering the exposure of rural areas to weather related hazards, often exacerbating already existing vulnerabilities. Spatial analysis of vulnerability to specific climatic risks can provide further entry points for adaptation. Given the importance of climate sensitive sectors for rural development progress, climate proofing of development processes is urgently needed through a pro-active management of current and future climate risks.

Keywords: Adaptation, climate vulnerability, local knowledge, Peru

Diversity of land use and livelihood systems in the face of global change

a)	Biodiversity and crop production	213
b)	Biodiversity	229
c)	Agroforestry and non-tree forest products	247
d)	Forestry	267
e)	Conservation, environmental services and value chains in the Amazon region (GTZ, ACTO, AI, UNAMAZ)	287

Biodiversity and crop production

Oral Presentations	215
SUSY ALEJANDRA PINOS BARRETO, RAINER SCHULTZE-KRAFT, VOLKER HOFFMANN: Ethnobotanical Survey of Medicinal Plant Species Used by Traditional Midwives in Cotacachi, Imbabura Province, Ecuador	215
EIKE LUEDELING, JENS GEBAUER, ANDREAS BUERKERT: Climate Change Affects Traditional High-Altitude Fruit Pro- duction Systems in Oman	216
GUDRUN B. KEDING, BRIGITTE L. MAASS, DETLEF VIR- CHOW, MICHAEL KRAWINKEL: Traditional and Exotic Vegetable Diversity in the Field and on the Plate of Women in two Different Agroecological Zones of Rural Tanzania	217
JENNIFER LINN SCHREITER, GERHARD LANGENBERGER, JOACHIM HELLER, JOSEF MARGRAF: <i>Hodgsonia heteroclita</i> Hook. f. & Thomson (Cucurbitaceae) - A Neglected Oil Plant in Southwest China and its Relation- ship with the Weaver Ant <i>Oecophylla smaragdina</i>	218
Posters	219
RICHARD ONWONGA, BERNHARD FREYER, WALTER WEN- ZEL, JOYCE LELEI: Agricultural Biodiversity: Lessons from the Smallholder Tra- ditional Farming Systems of the Central Rift Valley Province of Kenya	219
VICTOR PATRICIO RUEDA AYALA, ROLAND GERHARDS: Mapping of the Distribution and Abundance of the Key Plant Species, Serious Invasive Weeds in the Galapagos Islands (Ecuador), and Development of a Management Strategy against these In- vasive Weeds	220
SUNDAY ADEDUNTAN, THOMAS OFUYA, JOSEPH FUWAPE: Influence of Land Use System on Diversity and Abundance of Insects in Akure Forest Reserve, Ondo State Nigeria	221
ABDOLMAJID MAHDAVI DAMGHANI, ALIREZA KOOCHEKI: Evaluation of Agrobiodiversity and its Effects on the Sustain- ability of a Wheat-Cotton Cropping System in Iran	222

- AKINDELE AKINNAGBE, OLIVER GAILING, REINER FINKELDEY:
**Genetic Diversity of *Mansonia altissima* (A. Chev.) and *Triplo-
chiton scleroxylon* (K. Schum) in an Agroforest Scenario in
Akure Forest Reserve, Nigeria** 223
- ONG-ARGE INSUNG:
**Botanical Characteristics, Yield and Chemical Compositions
of 4 Varieties of *Sorghum bicolor* Moench under the Humid
Tropical Climate in Southern Thailand** 224
- ARISOA MAMPIONONA RAJAONA, SANDRA MARIA GUIMARAES
CALLADO, MARC J. J. JANSSENS:
**Comparative Studies of Allometrical Parameters of Cashew
Trees in Northeast Brazil** 225
- SUPAPORN PONGTHORNPRUEK, SAVENT PAMPASIT, NIMIT SRIPRANG,
KONGSAKDI PROMTEP, PENSIRI NABHEERONG:
**Element and Heavy Metal Concentrations of Some Fern Species
at Phu-Soi-Dao National Park, Thailand** 226
- KINDOMIHOU VALENTIN, AMBOUTA KARIMOU JEAN MARIE,
SINSIN BRICE:
**Diversity of Soil Fertility Management Practices in Sudanian
Zone of Benin (Western Africa)** 227
- ERIC BETT, BERNHARD FREYER, JOB LAGAT:
**Effect of Agricultural Commercialisation on Selected Agro-
biodiversity and Household Income: A Case Study of Small-
holder Households, Nakuru, Kenya** 228
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Ethnobotanical Survey of Medicinal Plant Species Used by Traditional Midwives in Cotacachi, Imbabura Province, Ecuador

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This study was conducted in Cotacachi, Ecuador. The aim was to establish a relation between the conservation of some wild plant species and traditional healing practices of Cotacachi midwives, as well as the impacts of that relation on the rural development strategy of Union of Farmers' and Indigenous Peoples' Organisations from Cotacachi (UNORCAC).

Cultural and biological diversity are seen as two sides of the same coin, thus, with the actual cultural and environmental changes both are being lost. Women play a key role in the conservation of wild species that are of high importance to the poor since they are a source of food, energy, fibers, feed and medicine. Such species require little inputs and they scope with the multi-task duties of women and their responsibility for the sustainable livelihood of the family. Midwife members of a group called "Jambi Mascaric" were interviewed, in order to gather information related to the plant species that they use. Based on those interviews traditional healing practices, diseases and other special conditions influenced by the Andean cosmovision were identified. Follow-up interviews allowed gaining an insight about the local classification system of plant and animal species.

There is a direct relation between traditional healing practices of midwives in Cotacachi and the conservation of some wild plant species. Because of this, midwives of Cotacachi play a key role in the preservation of local knowledge and biodiversity in the study region. Their role is also necessary to achieve the goal of UNORCAC members: "development with identity".

Further studies are recommended related to population density and distribution of wild species. It is also recommended to increase the sample size and include midwives from other areas. Based on that cultivation of the most threatened species could be attempted.

The study concludes that in today's global economy, indigenous people are vulnerable to rapid economic and cultural change and a better understanding of their traditional ways, including traditional uses of plants, could point to strategies to diminish the negative impacts of that change.

Keywords: Biodiversity, traditional knowledge, midwives, traditional healing practices, wild species

Climate Change Affects Traditional High-Altitude Fruit Production Systems in Oman

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The high-altitude fruit production systems of Al Jabal al Akhdar in Oman are unique in that they represent the only horticultural systems of the country, where farmers successfully grow temperate tree and shrub crops together with subtropical ones adapted to cool temperatures. To characterise the climatic conditions prevailing in the oases of this region, we investigated four oases along an elevation gradient from 1030 to 1950 masl. At the oases of Al 'Ayn, Qasha' and Masayrat ar Ruwajah, temperatures were measured at half-hourly intervals over a full cropping year, and interpolated for Salut, a fourth settlement at an intermediate altitude. At all oases, all trees were counted and classified according to species, climate preference and approximate chilling requirement.

From temperature measurements at the oases, we calculated the chill hours (temperatures below 7.2°C) at each location, and correlated these to daily measurements of minimum temperature from the nearby weather station at Saiq. From this correlation and historical temperature records at Saiq, seasonal chill hours for winters were estimated from 1983 to 2007.

Temperatures varied strongly with altitude, with mean annual temperatures of 24.7°C at the lowest and 18.7°C at the highest oasis. The lowest system was dominated by date palms (*Phoenix dactylifera* L.) and tropical species, whereas at the highest location pomegranates (*Punica granatum* L.) and roses (*Rosa damascena* Mill.) prevailed. Long-term temperature records indicated that the number of chill hours decreased markedly over the past 24 years. In our view, this decline is the most likely cause for the almost complete crop failure of pomegranate, peach (*Prunus persica* L.) and apricot (*Prunus armeniaca* L.) in the oases at intermediate altitude and very low yields of peach and apricot at Al 'Ayn during the season of 2005/06. The rate of decline in chill hours is alarming, with the annual total at Al 'Ayn decreasing by 17.4 hours per year, from 1047 hours in 1983/84 to less than 350 hours in all winters between 2003 and 2007.

Keywords: Oman, chilling requirement, climate gradient, oasis, pomegranate

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Traditional and Exotic Vegetable Diversity in the Field and on the Plate of Women in two Different Agroecological Zones of Rural Tanzania

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A high level of agrobiodiversity, which provides important nutritional diversity is a valuable resource in supplying the necessary nutrients for a health-oriented human diet. Moreover, traditional foods, particularly vegetables, are usually more nutritious compared to exotic alternatives. Despite this, traditional vegetables are still neglected in research and development.

In a study on diversity of both traditional and exotic vegetables, the production, gathering, and consumption of vegetables of 291 women were studied by interview. This research was performed during both dry and rainy season in three different rural districts (Muheza, Kongwa, Singida) situated in two different agro-ecological zones of Northeastern and Central Tanzania. Vegetable diversity produced and consumed by women was influenced not only by agro-ecological zones but also by seasonality, the distance of consumers to urban centers, and individual preferences. Consequently, vegetable diversity used over the whole year varied to a great extent among the three districts researched (Muheza about 70, Kongwa 35, Singida 20 different vegetable types). The mean number of vegetable types consumed per woman and week varied among districts and between dry and rainy season (Muheza dry 6.6 / rainy 7.8; Kongwa 4.9 / 6.1; Singida 6.1 / 5.4). Similarly, the daily amount of vegetable consumed also varied (Muheza dry 210g / rainy 140g; Kongwa 300g / 230g; Singida 290g / 280g). Women in Muheza district with the highest vegetable diversity available, consumed the lowest amount of vegetables.

In general, traditional vegetables were consumed more often and also in a larger quantity than exotic vegetables because of the distance of consumers to urban markets and exposure to exotic types. However, it remained open if exotic vegetables are eaten instead of or additionally to traditional ones.

This study identified factors influencing production and consumption of vegetables. Further work is needed to compare the impact of both vegetable variety and traditional versus exotic vegetable consumption on the health of women, especially in terms of micronutrient supply.

Keywords: African traditional vegetables, Tanzania, vegetable consumption, vegetable diversity, exotic vegetables

Hodgsonia heteroclita* Hook. f. & Thomson (Cucurbitaceae) - A Neglected Oil Plant in Southwest China and its Relationship with the Weaver Ant *Oecophylla smaragdina

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Hodgsonia heteroclita is a traditional oil plant used in former times as a Non Timber Forest Product (NTFP) by the mountain tribes of Southwest China. In the 1960s it was identified by Chinese scientists as promising a commercial oil plant because of its oil content of up to 77% in its large seeds. Many experiments for cultivation were conducted but interest in the plant faded due to difficulties in cultivation and management. Juvenile plants obviously do not stand full exposure to sunlight which makes the species problematic for mono-cropping systems. Additionally, the species is dioecious and, so far, it is not possible to distinguish between the young male and female plants. The management is further challenged by the drupaceous fruit characteristic, which is unique in Cucurbitaceae and makes extraction of the seed laborious.

The huge loss of rainforest due to rubber cultivation in Southwest China creates a need for biodiversity protection. *H. heteroclita* provides a good example of how protection can be promoted by 'rediscovering' traditional useful plants which are endangered due to habitat loss. As a liana the species is well-suited to be integrated in a diverse forest garden system. Additionally, it shows a distinct ant-plant association with the Asian weaver ant *Oecophylla smaragdina*, which is well-known for its outstanding predatory power and can be used for natural pest control. *H. heteroclita* provides glands for the ants containing nutritional fluid as well as suitable habitat to build nests. Furthermore, the liana builds natural bridges for the ants to distribute between the trees they should protect, but this does not affect the trees by overgrowing or strangling them. In a forest garden system with fruit trees, the 'tree-liana combination' can therefore contribute to sustainable harvests of oil-seeds as well as of fruits without the application of insecticides, which makes the species especially interesting for organic farming schemes.

Currently, propagation and large scale integration into orchards and secondary forests are conducted in Xishuangbanna to protect *H. heteroclita* and to prepare it for potential future markets.

Keywords: Agroforestry systems, ant plant, biodiversity conservation, forest gardens, natural pest-control, neglected crops, NWFP, organic farming

Agricultural Biodiversity: Lessons from the Smallholder Traditional Farming Systems of the Central Rift Valley Province of Kenya

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Agricultural biodiversity (Agrobiodiversity) is a consequence of human activity, that in turn, depends on it for providing food and other natural resource-based goods. The present study gives examples from the Central Rift Valley Province of Kenya on how smallholder farmers preserved, maintained and utilised both planned and associated biodiversity on their farms. A total of 36 farmers, 12 from each study site (Gilgil, Lare and Molo), were selected for a detailed agrobiodiversity (crops, weeds, trees/shrubs, biotopes and livestock) analysis during the long and short rain seasons of 2004/2005. Semi-structured questionnaires, observations and farm transect walks were the tools used for data collection. Weed, tree/shrub, biotope and crop diversity were determined using Shannon-Weaver diversity index (H) and an index of crop diversification (ICD).

About 13 different crops were grown per site with maize, Irish potatoes and intercrops (maize/beans, maize/Irish potatoes, maize/Irish potatoes/beans and Irish potatoes/beans) being the major crops grown across sites. The ICD was significantly high during the long rain season. A variety of weed species were identified on crop fields with *Bidens pilosa*, *Pennisetum calendestinum* and *Conyza bonariensis* domineering across sites. In total, 31 (Gilgil), 22 (Lare) and 27 (Molo) different tree/shrub species were recorded with *Gravillea robusta* predominant across sites. The H for weeds and tree/shrub species was high (>1.5) for all sites. Biotopes varied from site to site but the hedgerow, with highest species diversity, and field margins were the most frequent biotopes. Cattle, sheep, goats, and chicken were the principal livestock kept at each site.

The chief benefits of agrobiodiversity were food and financial security, besides provision of construction materials, medicines, organic fertilisers, fuels, livestock fodder and nutrient cycling. Based on the diverse types of crops, livestock, weeds, trees and shrubs and the presence of biotopes on farm, the smallholder farming systems were ecologically sustainable.

Research and extension efforts ought to be directed towards the promotion of conservation and sustainable use of agrobiodiversity. Additionally, lessons should be drawn from the green revolution of the 70s, which nearly wiped out the traditional farming system of production and by extension agrobiodiversity.

Keywords: Agrobiodiversity, biotopes, green revolution, Kenya, smallholders

Mapping of the Distribution and Abundance of the Key Plant Species, Serious Invasive Weeds in the Galapagos Islands (Ecuador), and Development of a Management Strategy against these Invasive Weeds

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On the Galapagos Islands, invasive plants are of high threat to both agricultural and natural habitats, causing therefore damage to the welfare of farmers and native fauna and flora species, hence tourism and inhabitants. Approximately 475 species of introduced plants were found in the Archipelago. Quinine (*Cinchona pubescens*), elephant grass (*Pennisetum purpureum*), blackberry (*Rubus niveus*), guava (*Psidium guajava*), passion fruit (*Passiflora edulis*), and sauco (*Citharexylum gentryi*) in the agricultural zone of Santa Cruz are identified as the most severe invasive plants. The protected one (Park area) is also threatened by them. Several methods of controlling these plants are being attempted though, including chemical and biological control. Basic information on the distribution of these species is required to plan eradication programs and to identify reasons for invasions. A tentative plan of mapping these species has been developed by the Galapagos National Park, were the above mentioned species were identified. Nevertheless, a validation of the results is required. Consequently, this research is proposed with the aim to map the spatial distribution and abundance of those alien plants on Santa Cruz Island, and contribute to validate the previous results. A mobile GIS connected to a Handheld GPS is used for plotting. Sampling territories in patches of invasives are randomly established to take measurements of plants abundance, occurrence, and to determine interactions with native species. Information about plants biology, competitive ability and phenology are also to be collected in a literature review. The analysis of data will be done with Open Jump software with General Public License (GPL); a multilayer analysis with all the available shape files will be performed. Existing information and Geo-referenced maps of the islands will be provided by the cooperation partners PNG and CDRS. The results will be presented to the management authority of the Galapagos National Park, for further control and removal actions. Expected results are the determination of the competitiveness of invasive over the native flora, interaction with the ecosystem, prediction of future possible appearance and to propose a further work for ecological control of the species.

Keywords: Competitiveness, endemic, Galapagos islands, Geographic Information System (GIS), invasive plants, mapping

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Influence of Land Use System on Diversity and Abundance of Insects in Akure Forest Reserve, Ondo State Nigeria

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The study was carried out to assess the effect of land use system on insect diversity and abundance. Three land use (fallow land, cocoa agroforestry land, and untouched forest land) were selected for field work within Akure forest reserve. An hectare block were centrally demarcated in each of the forest type. The block was divided into twenty plots of 20 m × 20 m in size. Ten plots were randomly selected where insects collection and enumeration of tree took place. The enumeration entails identification of all woody plants with diameter at breast height (dbh) of at least 10 cm. Monthly collection of insects with sweep net and hand peaking were used in each selected plot. A total of 13,578 insects were collected and identified from the three land use: 5,182 from fallow land, 5,884 from cocoa agro forestry land and 2,492 from untouched forest land. The identified insects belonged to a total of 30 families and are distributed among 15 orders. Within fallow land a total of 5,184 insects belonging to 8 orders and 46 families; while cocoa agro forestry land consist of 5,884 insect that are distributed within 10 Orders and 50 families; and untouched forest land contain of 2,490 insects distributed within 10 orders and 56 species. The families and order with highest number of individual insects are Lepidoptera (4,000) and Orthoptera (1,260). These insects are mainly defoliators. Shannon-weaver diversity index for insects species for the three land use system were 2.306, 2.448, and 3.622 for fallow land, cocoa agro forestry land and untouched forest respectively. There was a significant difference in tree species diversity in the habitats. The species with highest frequency in the studied habitats The species with highest frequency per hectare is *Cordia platythrsa* (6) in fallow land, cocoa (50) in cocoa agroforestry land *Celtis zenkeri* in untouched forest land.

A total of 14, 26, and 41 species of tree were identified in the fallow land, cocoa agroforestry land and untouched forest respectively.

Keywords: Agroforestry, defoliator, diversity of tree species, cacao, fallow

Evaluation of Agrobiodiversity and its Effects on the Sustainability of a Wheat-Cotton Cropping System in Iran

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Biodiversity which is a necessity of sustainable agriculture can provide species that can act as natural enemies for biologic control or genes for increasing crop resistance to biotic and abiotic stresses. Improvement of biodiversity by introducing crop species which have functions similar to off-farm inputs, reduces agroecosystem dependency and increases its self-sufficiency and sustainability. In order to evaluate the agrobiodiversity of a wheat-cotton cropping system and its effects on ecological sustainability, a survey was conducted in Khorassan province (eastern part of Iran). Agrobiodiversity indicators were growing other crops than wheat and cotton, planting forage legumes, green manure and livestock presence and diversity in the farm. The data were collected from Neyshabour, Bardaskan and Ferdows using 518 questionnaires. Results showed that only 7.9 and 1.4 percent of farmers grow forage legumes and green manure, respectively. 78 percent of farmers grow at least one other crop than wheat and cotton. 47.5 percent of farmers have one or more kinds of livestock in their farms which are mainly considered for family consumption. Results also proved a significant correlation of all agrobiodiversity indicators with ecological sustainability in this cropping system. The present study showed that improving sustainability of wheat-cotton cropping systems through enhancing agrobiodiversity in Iran needs a multidimensional struggle by farmers, researchers and policy-makers in which researchers should conduct experiments in order to determine suitable plant species and cultivars for introducing to these farming systems as forage legume or green manure. Second, education and extension attempts should be done to make farmers familiar with several benefits of forage legumes and green manure and agronomic practices for their production. Finally, policy-makers should facilitate the atmosphere by supporting smallholder farmers in introducing new crops and animal husbandry through financial support, providing machinery and education as well as subsidy to pioneer farmers.

Keywords: Agrobiodiversity, forage legumes, livestock, sustainability, wheat, cotton

Genetic Diversity of *Mansonia altissima* (A. Chev.) and *Triplochiton scleroxylon* (K. Schum) in an Agroforest Scenario in Akure Forest Reserve, Nigeria

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Problems of too much pressure on land for the production of food and wood for the increasing population have made it mandatory to look into various ways of maximising the uses of forest land in different parts of the world. Under this high demand for land, the system of shifting cultivation which has been practised from time immemorial in Nigeria can no longer support the needs of farmers. As a result of this, agroforestry practices such as Taungya and “on-farm tree” approaches have received increased attention in recent times. However, genetic inventories of the tree component of these practices are missing. In the present study, genetic diversity of two important Nigerian timber species namely: *Mansonia altissima* and *Triplochiton scleroxylon*, growing in an agroforest land in Nigeria were assessed. For this purpose, fresh leaf samples of *Mansonia altissima* were collected from a Taungya Farm while *Triplochiton scleroxylon* leaves were collected from a farmland with scattered “on-farm trees”. To serve as control, fresh leaf samples of the two tree species were also collected from an old Permanent Sample Plot (PSP) which represents a primary forest. The genetic diversity was assessed using Amplified Fragment Length Polymorphism (AFLP) markers. For *Mansonia altissima*, out of a total of 108 scorable bands, 40 were polymorphic (37.0%). Its gene diversity which was very low in both Taungya farm and Primary Forest were 0.0418 and 0.0305 respectively. In case of *Triplochiton scleroxylon*, out of the total of 134 scorable bands, 113 were polymorphic (86%). Its gene diversity in the Primary Forest was 0.2192 while in the farmland with “on-farm trees”, its gene diversity was 0.2175. These results reveal that trees on agroforest lands show similar levels of genetic diversity as those in the primary forests. In essence, agroforest lands could be reservoir of valuable genetic resources.

Keywords: AFLP, agroforestry, genetic diversity, *Mansonia altissima*, on-farm trees, taungya, *Triplochiton scleroxylon*

Botanical Characteristics, Yield and Chemical Compositions of 4 Varieties of *Sorghum bicolor* Moench under the Humid Tropical Climate in Southern Thailand

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The research was conducted in 2 consecutive trials to study the botanical characteristics, yields and chemical compositions of 4 varieties of sorghum, i.e. Native sorghum; Khek noi (Nt-KN), Commercialized sweet sorghum (Com-SS), Klangdong1 hybrid sweet sorghum (Hyb-KD1) and Nameun hybrid-sweet sorghum (Hyb-NM), planted under the humid tropical climate at Nakhonsithammarat campus, Rajamangala University of Technology Srivijaya, southern Thailand. The first trial coped with the study of the botanical characteristics of 4 varieties of sorghums. Sorghums were planted in a 5×10 m plot until the cutting ages at three stages, i.e. flowering stage (F), milk stage (M) and dent stage (D). The plants were cut for study of the botanical characteristics and yields. The experimental units were allocated according to the 4×3 Factorial experiments in Randomised complete block design. It was found that the Hyb-NM provided the highest yield, number of leaves, height of stem, stem diameter, and leaf weight ($p < 0.01$). The Hyb-KD1 had the longest inflorescent ($p < 0.01$), whereas the Com-SS provided the highest weight of the inflorescent ($p < 0.01$). The second trial coped with the study of the influences of varieties, cutting age and the preservative methods on the pH, the neutral detergent fiber (NDF) and on the acid detergent fiber (ADF) of ensiled plant. The plants at different cutting ages from the first trial were used for ensilage with 4 different methods i.e. non-ensiled (NE), ensiled without any additives (E), ensiled with molasses (EM), and ensiled with molasses and inoculums (EMI). The experimental units were arranged according to the $3 \times 4 \times 4$ Factorial experiment in Randomised complete block design. It was found that the Hyb-KD1 had the highest NDF content ($p < 0.01$). The ensilage method affected the NDF ($p < 0.01$) but not the ADF content ($p > 0.05$) of the ensiled plants. All ensilage methods provided good silage quality with a pH range from 3.58 to 4.05. This research result implies that sorghum for animal feed can be cultivated well under the humid tropical climate in the south of Thailand. The yield and quality of the sorghum depends on the varieties. Preservative method by ensilage improved the quality and utility of sorghum for the ruminants.

Keywords: Botanical characteristics, chemical composition, preservative methods, sorghum, yield components

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Comparative Studies of Allometrical Parameters of Cashew Trees in Northeast Brazil

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The *Anacardium occidentale* L. is native to Latin America and has its primary centre of diversity in Amazonia and a secondary one in the Planalto in Brazil. In the Northeast region of Brazil, areas of more than 650 000 ha are planted with cashew. These areas represent 86,59 % of the national production of cashew, in the states of Ceará, Piauí, Rio Grande do Norte as main producers. Cultivation system of cashew in Northeast Brazil comprises the common cultivation: “Cajueiro Comun”, reproduction cutting: “Cajueiro Atípico” and precocious plants: “Anão Precoce”. Productivity was found to be associated with leaf area and internode length. It was reported that trees with excessive vegetative growth and long internodes bore less than those with slow or medium vegetative growth and conclude that high yield was associated with medium internode and moderate vegetative growth. It will be assumed that growth is essential but should not be favoured in cashew plantation to have a high yielding tree. The aim of the study is to use allometry to compare and evaluate the size of cashew trees and its consequences within different cashew plantation types and under different socio-ecological conditions in Ceará and Piauí. It will contribute to the improvement of cashew cultivation system in Northeast Brazil, in order to increase the production level. First, farming system and activities of farmers in Ceará and Piauí will be studied through a household survey including associated crops or animals. Then, cashew characterisation will be based on field measurement of cashew tree and on biomass partitioning. Finally, allometric parameters will be studied to determine the optimum plant canopy conferring high yield in cashew plantations. In addition, we will assess the market situations and identify other factors contributing to the production of cashew in these regions.

Keywords: Allometry, *Anacardium occidentale*, Northeast Brazil, cashew

Element and Heavy Metal Concentrations of Some Fern Species at Phu-Soi-Dao National Park, Thailand

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Ferns are naturally abundant in the forests of Thailand. Some of the fern species have a good possibility for use in phytoremediation process. The objectives of this study were to determine the accumulation of heavy metals in various fern species and to study the ecological effects of this heavy metals absorption. The study was conducted at Phu-Soi-Dao National Park (17° 41' -18° 04'N and 100° 56' -101° 09'E, elevation 600–1633 m above sea level) in Phitsanulok Province, Thailand. The soil and fern samples (193 plots and 330 samples) were taken in December 2005. Line transects method along the pathway and applied square plot of 1 × 1 m² were used for sampling. Soil properties, concentration of elements and heavy metal accumulation in ferns were analysed. The element Ca showed the highest mean concentration in root, stem and leaves. The element concentrations in the leaves decreased in the following sequence: Ca > Fe > P > Mg > N > K > Na > Mn > Zn > Ni > Pb > Cu > Cr > Co > Cd. Some ferns had a high potential for absorbing heavy metals from the soil. Among 19 terrestrial fern species, five species had high concentrations of heavy metal in leaves. *Adiantum caudatum* L. accumulated more Fe and Co than other species, while high Cu and Pb concentration were found in *Adiantum philippense* L. Zn, Mn and Cd were largely collected in *Pteris ensiformis* Burm.f., *Lindsaea ensifolia* Sw. and *Lygodium* sp., respectively. Different factors influenced the heavy metal accumulation in the plants. Heavy metal uptake was decreased when soil CEC was increased and accelerated organic matter in soil. The uptake rate of all these elements was promoted by low pH values that might be an explanation for their different accumulation. The result from this study shows the potential of using ferns in bioremediation to reduce the concentration of heavy metal from the environment.

Keywords: Fern, heavy metal, national park, Thailand

Diversity of Soil Fertility Management Practices in Sudanian Zone of Benin (Western Africa)

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Various soil fertility management practices are observed in the Sudanian agrarian zone of Benin. This study highlights some traditional practices such as agroforestry, fallow, animal parking, use of crop residues as organic fertilizer, post-harvests of grasslands, farming associations and rotations, which were commonly used by 67% of farms.

Five variant of agroforestry system were observed: (i) woody parks with *Parkia biglobosa*, *Vitellaria paradoxa*, *Adansonia digitata* and *Ceiba pentadra*; (ii) fields pioneers on forest territories; (iii) agricultural plots planted with fruit-trees of *Anacardium occidentale* and *Mangifera indica*; (iv) shifting cultivation using *Eucalyptus camaldulensis*, *Acacia auriculiformis* and *Leucaena leucocephala*; (v) fallows planted with *Tectona grandis* and *Gmelina arborea*. This traditional system is more largely used, as well as planted fallows of fruit trees, collective grazing fallows under contracts and fixed parking of sedentary herds. Crop residues and domestic wastes are largely exploited. Revenues from grasslands post-harvests were higher than those from leguminous plants and foster the control of flows of post-harvests residues and the development of mechanisms that guarantee grasslands. The cereal-leguminous plants account for 63% of farming associations, and are observed where the organic manure is less commonly used. Successions of cotton by cereals are associated with significant depletion in mineral while those of cereals by leguminous resulted in nitrogen gain.

The improved practices such as improved parks, composting, cropping of plants that enhance soil fertility (i.e. *Vigna unguiculata*, *Glycine max*, *Mucuna pruriens*, *Cajanus cajan*, *Aschynomene histrix* and *Moringa oleifera*) were adopted. Adoption rate of "Biological Cotton" increased by 8% per year and yielded 600 kg of cotton per ha while the non biological cotton showed 980 to 1200 kg per ha. It reduces investment costs, risks in animal and human health and enhances agroforestry practices. Improved cropping techniques such as thinning, flat ploughing, application of optimal quantities of mineral manure and of organic manure were successfully adopted by 25%, 52%, 71% and 55% of farmers respectively.

Keywords: Benin, agro-diversity, soil fertility, Sudanian zone

Effect of Agricultural Commercialisation on Selected Agrobiodiversity and Household Income: A Case Study of Smallholder Households, Nakuru, Kenya

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The Kenya government strategy for revitalizing agriculture (SRA; 2004–2014) presents strategic interventions to transform agriculture into a competitive and market-oriented enterprise. This strategy of commercialising agriculture is aimed at eradicating food insecurity and poverty at household level. However, it has been envisaged to negate efforts concerning conservation of agrobiodiversity and pose a greater threat to household food insecurity. There is therefore a need to find out the effect of commercialisation of on-farm agrobiodiversity. The research question was whether it is possible to meet the strategic objectives of SRA without compromising agrobiodiversity especially among smallholder farming community in Kenya. The paper first discusses aspects of the policy of promoting market-oriented production as opposed to conventional subsistence and diversified systems.

Secondly, it presents analytical results from intensive farmer interviews and finally draw conclusions and policy implications. This is an issue that warrants investigation to establish a reality of policy's effects on agrobiodiversity and household income and consequently food security. The study was carried out in the East Mau catchment, Nakuru district, in Rift valley, Kenya, an area that has recently undergone rapid land use changes.

The selected effect components of the study were number of crop/animal species kept for agrobiodiversity, proportion of marketed output for commercialisation and on-farm cash income per annum. Results reveal that market-oriented production increases income and crop diversity at household level. The study recommends diversification of commercial crops, livestock and popularising farm enterprise with products that can be utilised locally rather than depending on external market for food security.

Keywords: Agrobiodiversity, commercialisation, strategy for revitalizing agriculture

Biodiversity

Invited Paper	231
STEPHEN B. BRUSH: The Human Ecology of Biodiversity in Agroecosystems: Culture and Maize in Mexico	231
Oral Presentations	232
MARION MEHRING, SUSANNE STOLL-KLEEMANN, NADINE FRITZ-VIETTA, MONIKA BERTZKY, RAINER SCHLIEP, MARTIN HIRSCHNITZ: Success Factors of Biodiversity Governance	232
PAVLOS GEORGIADIS, VOLKER HOFFMANN, GOPAL S. RAWAT, VANDANA SHIVA: Status of the Medicinal Flora and Indigenous Knowledge in the Garhwal Himalaya, Uttarakhand, India	233
Posters	234
KOROUS KHOSHBAKHT, KARL HAMMER: <i>Allium paradoxum</i> (M.B.) G. Don: A New Entry for Mansfeld's Encyclopedia of Agriculture and Horticultural Crops	234
JONATHAN C. ONYEKWELU, REINHARD MOSANDL, BERND STIMM: Tree Species Diversity and Soil Status of two Natural Forest Ecosystems in Lowland Humid Tropical Rainforest Region of Nigeria	235
ABBAS HASSAN ALI, JENS GEBAUER: Effect of Tree Stem Diameter, Date of Tapping and Intensity of Tapping on Frankincense Yield of <i>Boswellia papyrifera</i> in the Nuba Mountains, Central Sudan	236
KOROUS KHOSHBAKHT, MEHRABIAN AHMAD REZA, KARL HAMMER: Phenotypic Diversity of Fruits and Kernels of <i>Prunus divaricata</i> Ledeb. in Northern Iran — Implications for Domestication and Utilisation	237
SITSKE DE GROOTE, EMMY DE CALUWÉ, PATRICK VAN DAMME: Dadobat-Development and Domestiation of Baobab and Tamarind	238

- BALAKRISHNAN NAIR:
Traditional Medical Knowledge Systems and Piracy: The Issues Related to Trips and Beyond 239
- LUIGI MILELLA, IVA VIEHMANNOVÁ, ELOY FERNÁNDEZ CUSIMAMANI, JAROMÍR LACHMAN:
Phenolic Content and Molecular Markers of Different Yacon [*Smallanthus sonchifolius* (Poepp. et Endl.) H. Robinson] Landraces 240
- SA-NGUANSAK THANAPORNPOONPONG, WIWAT SOMSAK, ELKE PAWELZIK, SUCHADA VEARASILP:
Yield of Amaranth (*Amaranthus* spp.) Grown in an Irrigated Area of Northern Thailand 242
- NIRMALA JOSHI, KATJA KEHLENBECK, BRIGITTE L. MAASS:
Traditional, Neglected Vegetables of Nepal: Their Sustainable Utilisation for Meeting Human Needs 243
- BAROMEY NETH, BÉATRICE KNERR:
Development Synergy for Core Areas in the Tonle Sap Great Lake Region: Challenges and Opportunities for Biodiversity Conservation and Sustainable Livelihoods 244
- BHUWON STHAPIT, PERCY SAJISE, V. RAMANATHA RAO, PAUL QUEK, FELIPE DE CRUZ, FROUKJE KRUIJSSEN, MAURICIO BELLON:
Good Practices of *in situ* Conservation of Tropical Fruit Tree Species Diversity: Linking Conservation and Livelihood 245
- PAUL BORDONI, IRMGARD HOESCHLE-ZELEDON:
Underutilised Plants - Engine to Achieve the Millennium Development Goals 246
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The Human Ecology of Biodiversity in Agroecosystems: Culture and Maize in Mexico

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Biodiversity in agroecosystems is most fully understood in relation to biological factors and processes, such as adaptation, natural selection, reproduction strategies, and gene flow. Nevertheless, because these ecosystems are managed and have evolved under both natural and human [“unnatural” (Darwin 1896)] selection, they cannot be fully understood by reference of biological and physical properties alone. Among the social sciences, anthropology, geography, and economics have all contributed to understanding biodiversity in agroecosystems by studying knowledge systems, selection, and valuation of diversity within and among crop species. The social science disciplines have contributed in such areas as measuring rates of genetic erosion, estimating the value of agrobiodiversity, and designing *in situ* conservation and participatory rural development programs.

A significant but only partially met challenge is to understanding how social factors affect crop evolutionary processes such as increasing infraspecific diversity of crop species and influence their population structure. This challenge requires that we view crop evolution and the creation of agrobiodiversity as on-going rather than processes that ended with crop domestication or at some other time in the past.

After reviewing some social science contributions to understanding the status and value of agrobiodiversity, the paper discusses the role of human ecology in understanding crop evolution. In particular, it examines the relation between cultural diversity and infraspecific diversity of crops. Using data from human ecology research on maize diversity in southern Mexico, the paper discusses the impact of social and environmental factors at the micro-regional and landscape levels on the distribution of maize diversity.

Keywords: Agroecosystems, biodiversity, maize, Mexico

Success Factors of Biodiversity Governance

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Biodiversity faces many threats to its ecological integrity and cultural significance. With international conventions and agreements, such as the Convention on Biological Diversity and the Millennium Development Goals, it is internationally tried to tackle both the phenomenon of biodiversity loss and the challenge to improve human well-being on a global scale. The World Conservation Union defines a Protected Area (PA) as an area of land and/or sea dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources. Especially in the face of global change PAs are a valuable instrument to safeguard biodiversity and support sustainable resource use. This paper presents results from the interdisciplinary research project Governance of Biodiversity (GoBi), which evaluates the success or failure for implementing biodiversity related policies.

A global survey on UNESCO Biosphere Reserve (BR) management was performed (n=213). Amongst others, professionals were asked to rank four different external threats (illegal activities, invasive alien species, climate change, pollution) according to their severity within the BR. The survey covered 78 out of 102 countries with an overall response rate of 42%. About half of the accomplished interviews are from developing and transition countries in Eastern Europe, Africa, Asia and Latin America.

Statistical analysis revealed regional differences with regard to the threats of highest relevance. One remarkable result is the exceptional position of non-high-income countries, mainly located in the Tropics, where illegal activities seem to be of highest relevance (59% of interviewees ranked with highest relevance) whereas global change aspects, such as climate change (11%), are less relevant. While in high-income countries invasive alien species (34%) are seen as most important external threat, followed by climate change (29%) and illegal activities (7%) are ranked as the endmost.

The results show that concerning global change management there is a big gap between high-income and non-high-income countries. The empirical material raised shows correlations between singular success and failure factors and allows for deriving cause-effect relations. Adaptable institutional arrangements including responsive leadership, capacity building and environmental education are necessary to manage biodiversity and ecosystems that have complex social, political, cultural and ecological dimensions.

Keywords: Biodiversity, governance, success and failure factors

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Status of the Medicinal Flora and Indigenous Knowledge in the Garhwal Himalaya, Uttarakhand, India

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India is one of the leading countries in the world in terms of the wealth of traditional knowledge systems related to the use of plants. The country possesses a huge indigenous knowledge on harvesting, storage and usage of medicinal and aromatic plants, which has been gathered over centuries. Because they are both a local health commodity and also expected to meet the growing world demand, medicinal plant species experience high pressures due to over-collection from the wild. At the same time, traditional knowledge on the uses of wild plants is declining rapidly due to a lack of awareness and the spread of allopathic medicine.

The majority of Indian medicinal plants recorded come from Uttarakhand, a state located in the central Himalaya. The region shows a high diversity of landscapes and microclimates, which counts for its rich biodiversity. Its largely rural population shows a wide cultural diversity, with communities of high ethnological interest. As a result, local authorities have appreciated the importance of developing a dynamic market of medicinal and aromatic plants. In the last five years, ambitious initiatives are in place aiming to support the sector by means of inventories, conservation, capacity building, training of small-scale farmers and certification.

The project uses a variety of qualitative research tools and herbarium collections in order to inventorize the wild plant resources used in traditional medicine and food in the districts of Garhwal, Uttarakhand. Investigations take place on the role, value, diversity and potential of wild plant resources. Based on direct observations and interviews, the project aims to assess challenges and market opportunities for the utilisation of indigenous knowledge and biodiversity as a way of improving the livelihoods of underprivileged communities in the hilly regions of the state. The results will be a contribution towards the completion of the full inventory of medicinal plants of the state and will be an input for the promotion of the wild plant sector by governmental and non-governmental agencies that work directly with farmers in the region.

Keywords: Ethnobotany, biodiversity conservation, indigenous knowledge, medicinal & aromatic plants, under-privileged communities

***Allium paradoxum* (M.B.) G. Don: A New Entry for Mansfeld's Encyclopedia of Agriculture and Horticultural Crops**

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More than 6040 plant species are included in the last edition (3rd) of Mansfeld's Encyclopedia of Agricultural and Horticultural Crops. The plant species that are included in these entries are (or have been) cultivated for food, forage, medicinal, oil, fibre, spice, green manure and other purposes. However plant species that are cultivated as forest trees and ornamental plants are not entered in these encyclopedias. In addition, most plant species that are used by marginalized families are also not documented. These "neglected" crops have been ignored by science and development but are still being used in areas where they are well adapted and are competitive. There is now renewed interest for the conservation, domestication and use of these existing wide range of so-called "neglected" crops. One particular species of interest is *Allium paradoxum* (M.B.) G. Don., which is a cultivated vegetable and spice used in home gardens. The genus *Allium* contains 600 to 700 species, but only a few species have been domesticated so far as vegetables, spices or ornamental plants. *Allium paradoxum* is not included in the last (3rd) edition of Mansfeld's Encyclopedia of Agricultural and Horticultural Crops. In this study, a field work was conducted in Northern Iran to investigate the domestication processes and contribution of local agricultural systems in the domestication and conservation of *Allium paradoxum*. This species, which is locally called "Alezi", was found as a cultivated vegetable and spice in home gardens of Paland region (36° 10" N and 52° 57" E, 1550 m asl.). The plant is used to prepare a variety of local and special foods. The contribution of home gardens to the domestication process of *Allium paradoxum* were highlighted

Keywords: Conservation, domestication, home gardens, Iran, *Allium* sp.

Tree Species Diversity and Soil Status of two Natural Forest Ecosystems in Lowland Humid Tropical Rainforest Region of Nigeria

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The species rich tropical rainforests have been and are still under intense pressure to satisfy local and international demands for timber and non-timber products, the long-term effect being degradation in terms of quality and quantity of the forest ecosystem. Tree species diversity and soil properties were investigated for a primary (Queen's) and two degraded (Elephant and Oluwa) tropical rainforest ecosystems in Nigeria. Queen's forest has not been logged within living memory while Oluwa and Elephant forests were last logged in early 1970s and 1990s, respectively. Differences in soil physical and chemical properties of the three sites could not be attributed to the effect of forest degradation since there was no discernable pattern in soil properties of primary and degraded forests. The differences appeared to be site specific. A total of 31 different families were encountered in all three sites (26, 24 and 22 in Queen's, Oluwa and Elephant forests, respectively). Queen's forest had the highest number of tree species (51), followed by Oluwa (45) and lastly by Elephant forest (31). About one third of all tree species identified in Queen's, Oluwa and Elephant forests were among the endangered tree species in Nigeria, a situation that calls urgent conservation measures. Species diversity index, species richness and species evenness followed the order: Queen's forest > Oluwa > Elephant forest, indicating that species diversity, species richness and species evenness in the three sites depended on the state of the forest, with diversity decreasing as the level of forest degradation increases. The similarity of species diversity of the once highly degraded Oluwa forest to that of Queen's forest shows that lowland tropical rainforests have the ability of returning to their original "species rich" situation even after significant degradation, provided the forest is left undisturbed for a considerable period of time.

Keywords: Degraded forest, primary forest, regeneration, species diversity, species evenness, tropical rainforest ecosystem

Effect of Tree Stem Diameter, Date of Tapping and Intensity of Tapping on Frankincense Yield of *Boswellia papyrifera* in the Nuba Mountains, Central Sudan

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Boswellia papyrifera (Del.) Hochst. locally known as tarak-tarak is a native forest species in Central Sudan. In the Nuba Mountains the species has a range of environmental and economic benefits to the rural communities. The up to 10 m height trees are tapped for the harvest of valuable frankincense (also called gum olibanum). Despite its importance very little scientific information is available to improve the tapping techniques and promote sustainable production.

A three factor randomised complete block experiment with three replications was set up in the Umabdalla natural forest reserve (11°40'N, 30°30'E) from October 2001 till May 2002. The first factor was tree stem diameter at 1.3 m height (dbh) at three different diameters (10–15 cm, 16–20 cm and >20 cm), the second factor was tapping date at three different times (October 7, October 15 and October 21) and the third factor was intensity of tapping at two levels (2 and 4 positions on the tree stem). Each treatment combination was assigned to three trees, making a total of 162 trees. Tree stems were tapped with the traditional tapping tool mengaf. The resin of each tree was collected, dried in the shade for ten days and weighed.

The results show that the dbh had a significant influence on the gum exudation of *B. papyrifera* trees. The total gum yield of the 10–15 cm, 16–20 cm and >20 cm dbh trees was 328, 469 and 809 g tree⁻¹, respectively. Tree tapping on October 15 gave the highest resin yield with 575 g tree⁻¹ compared to tapping on October 7 and October 21 with 561 and 494 g tree⁻¹, respectively. Increasing the tapping intensity from 2 to 4 positions caused an increase of resin by 25 %.

In conclusion, our result clearly shows that resin yield of *B. papyrifera* can be improved by modifying the tapping techniques. However, it is also recommended that the tapping intensity should be on a sustainable level in order to minimise the likelihood of damaging the trees and to safeguard frankincense production in the future.

Keywords: *Gum olibanum*, livelihood, non timber forest product, NTFFP, tapping, tarak-tarak

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Phenotypic Diversity of Fruits and Kernels of *Prunus divaricata* Ledeb. in Northern Iran — Implications for Domestication and Utilisation

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Domestication of *Prunus divaricata*, a shrub or fruit tree up to 10 m tall, offers considerable scope for enhancing the nutritional and economic security of farmers in the north of Iran. The fruits with 20 to 35 mm in diameter are eaten fresh or used to prepare marmalade as well as a local tart. Moreover, this species is used as rootstock for plum and peach cultivars. Wild and semi-cultivated populations of this species are occurring in the southern part of Caspian Sea showing considerable variability in their fruits and kernels characteristics making them good candidates for domestication. In spite of the fact that, *P. divaricata* is a valuable fruit tree, only little research efforts have yet been dedicated to explore its potential for further domestication. Consequently, this study tries to determine the extent of phenotypic variation in fruits and kernels of this species implying in domestication and germplasm conservation programs. Eight fruit and kernel traits were assessed on forty ripe fruits from one hundred eighty trees in six wild and semi-cultivated populations. There were important differences between wild and semi-cultivated trees. Significant and continues tree-to-tree variation was found in fruit mass (2.1 to 6.7 g), flesh mass (1.76 to 6.3 g), nut mass (0.25 to 0.40 g), shell mass (0.16 to 0.24 g), kernel mass (0.9 to 0.16 g), fruit length (16 to 34 mm), fruit width (10 to 19 mm) and flesh depth (4 to 10 mm). Mean fruit length, fruit width, fruit mass, shell mass and kernel mass differed significantly between wild and semi-cultivated populations. Strong relationships were found between fruit weight and other fruit traits. These results represent the first quantitative assessment of tree-to-tree variation in fruit and kernel traits and is discussed with regard to the domestication and utilisation potential of this species in the northern Iran.

Keywords: Domestication, Iran, phenotypic variation, wild fruit trees

Dadobat-Development and Domestication of Baobab and Tamarind

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Both baobab and tamarind are plant species with high potential for arid and semi-arid areas in the developing world. They can provide food, medicine, wood and a number of secondary processed products for income generation that can help to meet basic needs of an increasing number of people in a context of decreasing land availability. The strategic overall objectives of the project that will be addressed through a multi-pronged and multidisciplinary research approach are: evaluation and characterisation of germplasm collected in four African countries in different ecological zones (Benin, Ghana, Mali and Senegal); eco-physiological characterisation of field and greenhouse-grown material; domestication of superior germplasm material; development of adapted cropping techniques; development of adapted plant material for introduction into (traditional and improved) agroforestry systems; evaluation of nutritional/medicinal composition of different plant parts; improvement of processing/transformation of the species' products; and development of (inter-) national marketing strategy. The project addresses issues of new crop/niche development through a holistic research approach and envisages multidisciplinary activities to broaden availability of improved plant material for introduction into agroforestry systems.

The project combines activities of research, capacity building and transfer to bridge the gap between knowledge to successful application of the results by the end users. The work plan is divided into 6 work packages and a documentation and information dissemination work package.

1. Field characterisation of plant material over different agro-ecological zones in the 4 countries, and match macroscopic characterisation using 'traditional' descriptors with results of molecular fingerprinting;
2. Eco-physiological characterisation of plant material for understanding drought stress tolerance/resistance *in situ* and *ex situ*;
3. Domestication: determination of optimal germination conditions and maximum germination rates;
4. Development of improved cropping techniques: pruning, irrigation, fertilisers, etc.;
5. Characterisation of nutritional and medicinal properties of primary and secondary products;
6. Production and marketing chain analysis, including socio-economics and SWOT analysis.

Keywords: Agroforestry, baobab, domestication, ethnobotany, genetic fingerprinting, market chain analysis, tamarind

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Traditional Medical Knowledge Systems and Piracy: The Issues Related to Trips and Beyond

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TRIPs (trade related intellectual property rights) agreement stipulates minimum standard that WTO member countries are required to adopt on patent laws. TRIPs however, presently do not have adequate provisions for protection of Intellectual Property rights of Traditional Knowledge. In the absence of any protective mechanism the TK holders are deprived of any benefit actually derived from their knowledge. It stipulated that access to genetic resource could be based on mutually agreed terms with Prior Informed Consent (PIC) and equitable benefit sharing. The diverse expressions of medical knowledge in Indian society can be fitted into two sets of traditions, viz., (a) codified traditions and (b) folk medicine. In the Indian context, the codified medical traditions are drawn from knowledge systems like Ayurveda, Unani, Siddha and Gso-rig-pa (the Tibetan system). The codified traditions are evidently in the Indian public domain by virtue of their accessibility. The custodians and carriers of these traditions in India are spread across 4639 ethnic communities. The Local Health Traditions (LHT) are mostly undocumented and oral. These oral or folk medical traditions are extremely diverse, since they are rooted in natural resources located in so many different eco-systems. They are dynamic, innovative, and evolving. These health traditions consist of various health practices that are based on local epistemologies and empirical experience. Both in the written and oral tradition there have been a definite 'culture of ethical sharing'. There are no regulatory measures to prevent deliberate bio-piracy of herbs from the wild and the rapidly expanding market of traditional medicine. Convention of biodiversity (CBD) is the only internationally binding agreement that clearly indicates protection of TK. It stipulated that access to genetic resource could be based on mutually agreed terms with Prior Informed Consent (PIC) and equitable benefit sharing. Several problems related to promotion and protection of traditional knowledge goes beyond TRIPs and others remain unresolved in the present framework of TRIPs and CBD.

Keywords: Benefit sharing, convention of biodiversity, intellectual property rights, traditional knowledge, prior informed consent

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Phenolic Content and Molecular Markers of Different Yacon [*Smallanthus sonchifolius* (Poepp. et Endl.) H. Robinson] Landraces

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Yacon [*Smallanthus sonchifolius* (Poepp. et Endl.) H. Robinson, *Asteraceae*] is a perennial herb originally cultivated in South America and now introduced and cultivated in several other countries. The productivity and other valuable agronomic traits of yacon strongly suggest that it is a species with a great potential and recently, the attention on it is grown up, also due to its nutritional characteristics and its phytoterapeutic use. It is cultivated for its tuberous roots that have exceptional qualities for low-calorie diets thanks to its abundant content of fructooligosaccharide and for the absence of starch. Otherwise leaves extract is very rich in phenolic components with strong antioxidant activities and, recently, it was demonstrated that it also possess hypoglycaemic properties. The aim of this work is to investigate total phenolic content and genetic distance among five different yacon landraces collected in different countries. Total phenolic content was measured in the five clones and it resulted to be undoubtedly different among landraces analysed from 34,94 mg g⁻¹ to 68,49 mg g⁻¹. Results obtained were compared with those shown applying RAPD (Random Amplified Polymorphic DNA) and AFLP (Amplified Fragment Length Polymorphism) markers for the analysis of genetic diversity. Using 61 RAPD primers, 85 information bands were identified, corresponding to 28.7 % of polymorphism. In comparison, only six selected AFLP primer pairs produced 84 information bands, with a similar percentage of polymorphism (23.4 %). Polymorphic markers were analysed separately. Cluster obtained for each molecular marker showed two main groups that include the same genotypes but with different clustering. It is interesting to underline that the two branches divide landraces in two groups that include landraces with the higher and the lower phenolic content, respectively. Moreover, the two groups respect some phenotypic characters but they do not reflect faithfully their geographical origin. Data obtained suggest that the two molecular markers applied are useful to investigate intraspecific genetic variability in *Smallanthus sonchifolius*. The dendrograms based on these data sets graphically depicted the ability of both methods to differentiate all the cultivars studied and as results reflect their phenolic content.

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Keywords: AFLP, genetic diversity, phenolic content, RAPD, yacon

Yield of Amaranth (*Amaranthus* spp.) Grown in an Irrigated Area of Northern Thailand

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Amaranth (*Amaranthus* spp.) have received during the last decades more attention due to its high nutritive value of the seeds and its ability to adapt to diverse environments. However, information about agronomic characters and yield performance in Thailand is very rare. The aim of this study was to evaluate the possibility to produce amaranth seeds under the climatic conditions of Northern Thailand. The experiment was carried out from November 2006 to March 2007 at the Department of Agronomy, Faculty of Agriculture, Chiang Mai University, Chiang Mai, Thailand. Eight varieties of amaranth were planted and their agronomic characters were studied. The seeds of the different varieties were harvested according to their maturity 90 to 101 days after germination (DAG). The vegetative growth of the plants was rapidly established and increased significantly after 56 DAG. The varieties “K432” and “Pastevny” showed photosensitivity to short-day length and their reproductive phases appeared about 20 days earlier than in the other varieties. Significant differences among varieties ($P < 0.05$) were observed for plant height, yield per plant, plant dry weight and harvest index (HI). Plant height varied from 38 to 102 cm, yield per plant from 1.05 to 5.95 g, plant dry weight from 4.5 to 19 g per plant and HI from 22.5 to 33.7. However, there were no significant differences in the thousand-kernel-weight. Five varieties (“AMR”, “Baernkraft”, “K266”, “K283”, “Rawa”) showed good agronomic properties (including no plant lodging) as well as good seed yield potentials ranging from 3.86 to 5.95 g per plant. It can be concluded that the studied amaranth varieties adapted well to the climatic conditions in the irrigated areas of Northern Thailand. Studies about the plant population density and various cultural practices are the next steps to introduce in the future amaranth for seed production.

Keywords: Agronomic character, *Amaranthus*, irrigation, Thailand

Traditional, Neglected Vegetables of Nepal: Their Sustainable Utilisation for Meeting Human Needs

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Nepal's biodiversity is associated with the country's breadth topographic, climatic, and agroecological conditions, ranging from tropical to alpine regions. About 1,500 of the occurring 6,500 plant species are considered useful. However, most of them, including many traditional vegetables, are regarded as underutilised/neglected. Vegetables gathered from the wild or cultivated in homegardens play an important role in food and nutritional security of rural households particularly in remote areas. This study aimed to document the occurrence and utilisation of traditional vegetables in Nepal, and assess their plant genetic resources conservation status.

Traditional vegetable species were collected from natural habitats, homegardens, and farmers' fields during field surveys in five Nepalese districts, covering elevations from 200 to 4,200 m asl. Information on local names, utilisation and seasonal availability was gathered by farmers' interviews, personal observations, market surveys, and literature review.

In total, 184 traditional vegetable species were recorded in the field survey. Species composition and numbers differed along the elevation gradient. About 50 traditional vegetable species were documented in the market surveys. Thus, traditional vegetables not only contributed to subsistence production and nutritional security of the farmers' families, but also to their income generation. As women were particularly involved in gathering, cultivating, and trading traditional vegetables, their economic status within the families was strengthened. Both wild and cultivated traditional vegetables were reported to play an important role as emergency food during times of scarcity.

A wide range of traditional vegetables is commonly used in Nepal, but the importance of these species decreases, particularly in easily accessible regions. This is due to regional development, such as the promotion of the use of exotic vegetables. To avoid or at least minimise the impending genetic and cultural erosion of traditional germplasm, the respective indigenous knowledge of germplasm should be documented and collected. The utilisation and cultivation of these vegetables should be promoted to maintain the dietary needs of the households in rural Nepal.

Keywords: genetic erosion, homegardens, food security, plant genetic resources

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Development Synergy for Core Areas in the Tonle Sap Great Lake Region: Challenges and Opportunities for Biodiversity Conservation and Sustainable Livelihoods

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In order to achieve economic development and poverty alleviation goals in a natural resources rich region, more attention should be paid to conserving and sustaining its biodiversity. Many studies have proved that biodiversity conservation and sustainable livelihoods in rural areas need to be addressed correctly and concurrently. Even if, recently, the willpower of Cambodian government to apply integrated and systematic approaches in natural resources management (NRM) and sustainable development in Tonle Sap Great Lake (TSGL), a region of chronic human poverty, it is elusive that success can be achieved easily. Therefore, there is a need for the government to maximise the development synergy to promote sustainable rural community livelihood while building a culture of sustainable use of natural resources. This will help to make biodiversity well-preserved from the effort of local communities and other interest groups.

Using the case of TSGL core areas, Boeung Tonle Chhmar and Stung Sen, in northern Cambodia, this article discusses the intervention of multi-sectoral policies and development frameworks in the region. A number of integrated mitigation mechanisms for local livelihood improvement and NRM have been debated in the paper. The study provides alternative insights concerning livelihood situation and capital assets of locals. Current and future development aids, challenges of poverty-related activities and institutional adjustment of concerned institutions in supporting more community development and incentive-driven conservation are also argued. This paper shows that the Cambodian government and its development partners should consider short-term and long-term development objectives to apply in TSGL core areas. In pursuit of success, following strategies need to be taken into serious account: good political will; local empowerment; clear definition of boundary and responsibilities; good coordination and collaboration among concerned stakeholders; investment in local small, medium and micro enterprise economy (SMME) in TSGL core areas and in nearby regions; payment for environmental service (PES) and appropriate environmental management system (EMS); harmonisation and integration of policies and projects; and appropriate land use planning.

Keywords: Biodiversity conservation, development synergy, sustainable livelihood

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Good Practices of *in situ* Conservation of Tropical Fruit Tree Species Diversity: Linking Conservation and Livelihood

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Tropical fruits are not only an integral part of culture in Asia but are also important as source of income and for their food and nutritional values. They contribute towards the well-being of people and enhancement of the environment as part of the agricultural ecosystem and tropical forest. Traditionally these tropical fruits are managed in a variety of production systems such as in natural forests, protected areas, buffer zones, homegardens, semi-commercial and commercial orchards. As a component of the homegarden, tropical fruit species are grown to serve the cultural and economic needs of farming communities. Homegardens are also the repository of the genepool of tropical fruit species taken and cultivated from the forest areas especially for communities occupying fringes of forest ecosystems or protected areas.

Over the years, farmers along with formal research institutions, have developed a range of production and management practices to conserve and sustainably use tropical fruit species diversity in Asia. These good practices can be a process, a method, a technique, an institutional arrangement or any combination of these, which attains the objective of both conservation and sustainable use of these fruit species diversity. In recent years, scaling up of good practices has become a popular strategy for improving research and development options to reduce rural poverty and vulnerability. This paper aims to identify good practices for sustainable management of tropical fruit tree diversity from current practices around the globe. Strengthening capacity of human and social capitals of local communities to document and blend traditional knowledge with scientific knowledge to manage tropical fruit diversity is the fundamental process to translate good practices into reality on the ground. These practices should be practical, cost-efficient, sustainable, and have the potential for scaling up to wider geographical, institutional and socio-cultural contexts. Based upon the above criteria, case studies illustrate examples of good practices of conservation and sustainable use of cultivated and wild tropical fruit tree species in Asia, which, at the same time, help the farmer benefit from growing tropical fruit species.

Keywords: Homegardens, *in situ* conservation, livelihoods, sustainable use, tropical fruits species, fruit wild species

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Underutilised Plants - Engine to Achieve the Millennium Development Goals

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The role of agricultural biodiversity and, in particular, the one played by many underutilised plant species as easily accessible assets of the poor to improve livelihoods, has not been fully recognised and capitalized upon by development organisations, policy- and decision-makers. Traditional plant species, today often fallen into disuse due to various reasons, offer solutions at hand and of key importance for resource-poor people to move out of hunger and poverty. Underutilised species represent an enormous range of different plants with different attributes and potential to contribute to poverty alleviation. While some are more important for food security, others will have a greater potential for income generation, environmental services and/or provide cultural benefits. Besides still being an essential part as food and fodder in rural communities, these species play a role as risk buffers for human and animal food security during times of environmental and social disasters. Their adaptation to varying environmental conditions and often marginal areas based on a long selection process by farmers, enables them to produce reliable yields when most introduced and modern crops fail. Often rich in vitamins and micronutrients, they provide resource-poor people with a balanced diet that is socially and culturally acceptable. If strategically marketed, they generate additional income and contribute to the conservation of biodiversity, thus expanding the options available for the poor farmers to respond to environmental and on climatic changes.

Making more use of underutilised traditional plant species will contribute towards the achievement of several MDG, namely MDG one (hunger and poverty), MDG three (gender equality and empowerment of women), MDG four (child mortality), MDG five (maternal health) and MDG seven (environmental sustainability).

The paper will provide examples on how enhanced uses of these species have contributed at local level to meet rural communities' needs.

Keywords: Environmental services, food security, income generation, non-material benefits, nutrition, underutilised species

Agroforestry and non-tree forest products

Oral Presentations	249
TARIG GIBREEL, SIEGFRIED BAUER: Targeting the Challenges of Agroforestry System Disappearance under Rapid Commercialisation: Factors Affecting Farmers Land Use Options in the Gum Belt of Western Sudan	249
BABURAM RIJAL, RAJENDRA K. C., NETRA BHANDARI, CHRISTOPH KLEINN: NWFP Resource Assessment: Options and Challenges to Maximize Potential Contribution of NWFPs in Conservation	250
ANDREW K. KIPLAGAT, DANIEL MUGENDI, JOHN MBURU: Valuation of the Economic Role of NTFPs Consumption by Rural Households Living Around Kakamega Forest, Western Kenya	251
BENNO POKORNY, GABRIEL MEDINA, JAMES JOHNSON: “The King Is Naked”: a Critical Analysis of the Community Forestry Concept as Applied in the Amazonian Region	252
Posters	253
NETRA BHANDARI, RAJENDRA K. C., BABURAM RIJAL, VOLKER HOFFMANN: Community Based NWFP Management Initiatives: Innovations and Adoption in Non-Wood Forestry in Nepal	253
JAVAD MIRARAB, MAHBOOBEH FOSHAT, RAHIM MALEKNIA: Non-Wood Products as a Way Towards a Sustainable Extension	254
RAHIM MALEKNIA, MANOOCHHR NAMIRANIAN, REZA AZIZI, JAHANGIR FEGHHI: Effects of Traditional Agroforestry Systems on Forest Structure: Case Study in the West Forests of Iran	255
HASSAN ELNOUR ADAM, MOHAMED ELNOUR TAHA: Local Knowledge of the Use of Indigenous Trees and their Management in Rural Communities in North Kordofan State, Sudan	256

- BARBORA ROUSOVA, JANA LOJKOVA, BOHDAN LOJKA, JAN BANOUT, ZBYNEK POLESNY:
Agroforestry Systems Acceptability in Pucallpa, Peruvian Amazon 257
- BRUNA MISSAGIA:
Land Use Management in Rural Areas of the Brazilian Atlantic Forest 258
- ANTONIO CARLOS REIS DE FREITAS, JAVIER DAVID SOSA RUIZ, CHRISTOPH GEHRING, ARIMAR LEAL VIEIRA:
Relationship Between Production Systems and Environmental Impacts in a Buffer Zone: Case Study in the South-Eastern Periphery of Amazonia, Maranhão State, Brazil 259
- JAN-PETER MUND:
Vulnerability and Resilience of the Cambodian Forest-Rural Interface 260
- MICHAEL KRAUSE, HOLM UIBRIG:
Risk in Diversifying Agricultural Land Use: Perceived Impacts of Woody Species and Livelihood Diversification Strategies in the Central Highlands of Ethiopia 261
- DO TRAN VAN:
Forest Tree Regeneration on Fallow Land after Shifting Cultivation in the Northwest Region, Viet Nam 262
- ISABEL MARIA MADALENO:
Sustainable Livelihood Examples from Water Deficient Easter Island and the Lower Amazon River Floodplains 263
- JUAN CARLOS CAMARGO, CHRISTOPH KLEINN:
Effect of Environmental Factors on Productivity of *Guadua angustifolia* Stands in Coffee Region of Colombia 264
- UNDINE BEYERSDORFF, MICHAEL CHIRWA, MARION HERGARTEN, GERALD MEKE, IRMA MIKA, VIOLET MSUKWA, USTANZIOUS NTHENDA, JANA ROHRBACH, NINA STEPHAN:
Cost-Benefit Analysis of Land Use Alternatives in Malawi 265
- CHRISTIANE EHRLINGHAUS:
Mobility, Rural-Urban Linkages, and Land Use Change: Implications for Forest Livelihoods and Land Tenure Security in Amazonian Extractive Reserves 266
-

Targeting the Challenges of Agroforestry System Disappearance under Rapid Commercialisation: Factors Affecting Farmers Land Use Options in the Gum Belt of Western Sudan

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Agroforestry is seen as an appropriate farming strategy to obtain a sustainable farming and to stabilise rural economies in developing countries. The Sudanese gum arabic production system is facing the conversion of the acacia's land into commercial cropping enterprises. This has an adverse impact on the smallholders' welfare and intimidates the sustainability of the land use system. Gum arabic is an important non-wood forest product (NWFP) obtained from *Acacia senegal* tree. Sudan accounts for nearly 80 % of the world production and controls 60 % of gum arabic world market. Gum arabic is also a significant source of cash income for the peasant communities occupying the gum belt, it accounts for 15 % of the gum arabic producers' income and 10 % of other farmers. However, its production has slumped over the last three decades.

This paper analyses the determinants of agroforestry system practices and assesses the impact of commercialisation on the farm household resource allocation decisions in the gum belt in western Sudan.

Results from commercialisation index (C1) and Two-Stage Least Square model (2SLS), confirm a positive significant influence of commercialisation as well as the investment in livestock on the production of food crops. Furthermore, results from the probit model revealed that, an adequately attractive price level, equivalent to off-farm income, provides a motivation for a sustainable gum arabic production system. Finally, household decisions to allocate more resources to cash crops, to market access and to invest in livestock, in order to spread risk, appear justified especially under a degraded agricultural production environment. Therefore, increased farm gate prices for gum arabic producers will provide an incentive to use the land in a gum arabic agroforestry system, and this will lead to a win-win situation by enhancing cash and food crops productivity and environmental stability.

Keywords: 2SLS, Acacia, commercialisation index, dryland, gum arabic, Sudan

NWFP Resource Assessment: Options and Challenges to Maximize Potential Contribution of NWPs in Conservation

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Non-Wood Forest Product (NWFP) has received increasing hierarchical demands from local to national levels for different scopes of uses since a couple of decades in Nepal. Its scientific management is common concerns as a new discipline unlike timber management which is backed up by significantly older data, well established management tools and long experiences. Its complexities in distribution and habitat make the assessment rather difficult as compared to conventional forest inventory. Efficient inventory techniques support to acquire more precise data on growing stock and other management parameters which are the bases of scientific management in all hierarchical structure from local community-products relation to national policy frameworks are the current needs in NWFP management. This article explores and analyzes the various sampling techniques used in various NWFP inventories in Nepal and discusses possibility of product base inventory designs to make the estimation biometrically sound and community adoptive.

Spatial distribution, ecological setting, physiography, and cost are the general considerations on sampling design. Among the well established sampling techniques such as simple random, systematic, adaptive cluster sampling (ACS) etc., systematic sampling is most common in practice in contemporary Community Forest Inventory and National Forest Inventory in Nepal in timber forestry and it is considered as legally mandatory as well. NWFP assessment is based on methods applied in inventory designed for timber management which is not efficient way. It creates the necessity of further research on the area.

Inventory of *Nardotachys grandiflora* (herbs: rhizome), *Rhododendron anthopogon* (shrub: leaf), *Juniperus indica* (tree: berry) have been taken for discussion on systematic sampling and scope of its alternatives based on field. Based on applied statistics and literatures found, comparative discussion has been presented on other sampling techniques. Availability-abundance of these species is observed in cluster form. Microclimate affects abundance within a small quadrants/strip and spatial discontinuation is clearly visible soon. The study concludes that the ACS would be cost effective than the others in such type of products. It can take advantages of selecting the quadrants/strips wherever the targeted species is available in cluster and drop it when absence begins. It has minimal statistical rigorosity therefore local communities could adopt the methods preserving the statistical principles.

Keywords: Growing stock, forest inventory, Nepal, NWFP assessment, resource base

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Valuation of the Economic Role of NTFPs Consumption by Rural Households Living Around Kakamega Forest, Western Kenya

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Rural households largely depend on non-timber forest products (NTFPs) to sustain livelihoods, more so in meeting household basic daily needs. Specifically in Kakamega forest, households depend on NTFPs such as firewood to meet household energy needs, herbal medicines for ailment treatment, pastures to feed household stock, thatch grass to maintain shelters, and fruits and vegetables for food. Since these direct products are obtained from the forest free of charge and have no efficient market, their economic contribution to rural household economy remains unknown yet their role is factually immense. Establishing the economic value of NTFPs consumed by households therefore becomes very necessary in understanding the actual contribution NTFPs make in the sustenance of rural livelihoods.

This study estimated and compared economic value of NTFPs consumed by rural households living around Kakamega forest using three valuation approaches namely: substitutes' prices method, direct prices method and opportunity cost of time method. Socioeconomic, institutional and geophysical data that included household characteristics such as age, gender, household size, occupations, land and livestock ownership, NTFPs consumption quantities (and that of corresponding substitutes), time expended on extraction, time values, prices of NTFPs (and the substitutes) on local retail markets, distances to the forests and forest management regimes were collected in the areas surrounding Kakamega forest using a semi-structured questionnaire.

Results show that the substitute value is highest followed by directly priced value and lastly by the value generated through the opportunity cost of time, with an annual average consumption of US \$120, US\$92 and US\$78, respectively, per household. The paper concludes with important policy recommendations for conservation of Kakamega forest.

Keywords: Economic value, non timber forest products, rural households

“The King Is Naked”: a Critical Analysis of the Community Forestry Concept as Applied in the Amazonian Region

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Since the World summit in Rio in the year 1992, the concept of community forestry became more and more the focus of development organisation acting in the Amazon region. Based on the assumption that poverty is one of the main drivers for forest destruction, sustainable timber management was expected to contribute to one of the priority challenges of Amazon countries, to combine forest conservation with rural development. The considerable efforts of national governments supported by the international community resulted in a number of promising demonstration projects and remarkable improvements of national laws and regulations. To analyse the potential of community forestry for rural development, the EU financed international research project ForLive studied 16 community forestry initiatives throughout the Amazon in Bolivia, Brazil, Peru and Ecuador. The study revealed that current community forestry concept is repeating the errors of former development initiatives based on modernisation approaches. The implementation of predefined technological packages based on Reduced Impact Logging, the focus on timber and market approaches and its operationalisation in externally driven pilot projects resulted in relatively low success, a low probability for replication and may generate even negative effects to poor people. Community forestry implies the danger that smallholders are encroached for achieving the economic and environmental goals of more powerful parts of the national and global society. To effectively use forests as a basis for sustainable rural development, a drastic re-orientation is necessary towards approaches, which enable local communities to develop their own resource management strategies in accordance with their demands and capacities.

Keywords: Amazon, community forestry, rural development

Community Based NWFP Management Initiatives: Innovations and Adoption in Non-Wood Forestry in Nepal

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In a short period of time, Non-wood forest products (NWFPs) in Nepal have created plenty of off-farm employments by entrepreneurship on collection, semi-processing and marketing of the products. The multiplier effects and hierarchical benefits are now distributed from individual level to households, community and national level. Though the history of use and management of various NWFPs has long tradition in Nepal, there have been some significant achievements in conservation and rural development through the sustainable management of NWFPs in the recent decades. Economic exploitations for meaningful support to poorest of the poor and conservation are the major concerns nowadays.

NWFP trade and bartering in Nepal exists since the time immemorial, however the commercial trade of NWFP by the limited number of people begun in the 1950s. Since the commercialisation of NWFPs, various innovations in NWFP resource assessment, domestication or cultivation, marketing and enterprise development have taken place. One of the successful examples is community based NWFP management. Communities have initiated, mainly by themselves, sometimes with few external supports, domestication, cultivation. In the mean time there are many challenges in the adoption of NWFP innovations because of its immediate cash value and market liquidity as well as its common property in nature.

The objectives of this study are to explore the opportunities and constraints in NWFP innovation management in relation to its participatory initiatives and gradual developments since their scientific recognition to date and suggest future direction for their extension. The data were collected from various organisations, reports and publications as well as through the information obtained from interview with the professional involved in NWFP management.

This study concludes that in a very short span of its innovation to date, the sustainable management has taken momentum in many community forestry user groups (CFUGs). However there are many other CFUGs to be aware and support needed for extension and technology transfer. In national level policy frameworks, there is urgent necessity of bringing NWFP in the main stream of sustainable forest management and grant full right to the community for NWFP based economic activities for fulfilling the objective of conservation of the resources and economic development of rural people.

Keywords: Adoption, community forestry, innovation, Nepal, non-wood forestry

Non-Wood Products as a Way Towards a Sustainable Extension

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It is necessary to preserve the natural resources of the earth, because we are dependent to them ecologically and for obtaining food we need them. The world population is increasing rapidly so we should search for stable extension to meet the aims of preserving natural resources (ecological purpose), increasing the profit and efficiency (financial purpose) and fighting the poverty and extending equality (social purpose). In other words we should try to fulfil the triangular necessities of extension. The northern forests of Iran which cover 1.8 million ha are the main source of wood production and nearly 1.2 million ha of them are used for this reason. As the area for wood production is very low we should consider non wood products as a source of profit, too. So that we can help the forest and its inhabitants financially and prevent its destruction. This research was carried out in series 2 of Minodasht located in North-East of Iran. In this region 2 parcels covering 82 ha were using for wood production and 3 parcels with 97 ha were using for non wood production. In this region forest inhabitants harvest the forest fruits like plum (*prunus aviom*) and *punica grantum*. They use these fruits for making vinegar and they are used in industry for making food additives. The result show that the profit of industrial productions and the profit of forest fruits are nearly the same financially (50000\$ for industrial use and 43000\$ for forest fruits). If we consider the damages to soil and landscape and estimate them financially in industrial uses then efficiency of forest fruit over industrial uses would be significant. In conclusion we can say that if we shift the forest production from industry toward other natural resources of it like harvesting the forest fruits we would be sure that we are going toward stable extension and making job for forest inhabitant and be able to prevent forest destruction.

Keywords: Iran, non wood production, sustainable extension

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Effects of Traditional Agroforestry Systems on Forest Structure: Case Study in the West Forests of Iran

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Zagros forest in the west of Iran with an area of 5 million ha accounts for almost 40% of country's forests. More than 1.5 million people lives in this area. The forests with easy access located in gentle alps are used for non irrigated understory farming and for firewood whereas forests on steep slopes and at high altitudes are used for feeding livestock.

In order to study the effects of these forest management practices on the forest structure, two forest regions were selected: in the first region understory farming was practiced while in the second region this was not the case. In each region 30 plots were established. Results indicated that in forests where understory farming was practiced only *Quercus persica* occurred whereas in forest without understory farming *Acer monspessulanum*, *Amygdalus* sp., *Ficus* sp., *Pistacia mutica*, *P. khinjuk*, *Ddaphnia* sp. and *Cratagus* sp. occurred in addition to *Quercus persica*. In forest with understory farming 28% of the trees had seed origin and 72% had coppice origin. In forests without understory farming 60% of trees had seed origin, 34% had coppice origin and 6% were shrubs. Understory farming significantly reduced canopy cover and abundance of undergrowth plants. However, these farming lands located on gentle slopes, contribute significantly to the livelihoods of local peoples.

Keywords: Agroforestry, forest structure, traditional forest management, Iran

Local Knowledge of the Use of Indigenous Trees and their Management in Rural Communities in North Kordofan State, Sudan

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Forests and trees are important to rural communities in Sudan for providing them with food, shelter, wildlife habitat, fuel and daily supplies. This study was conducted in North Kordofan State, which is facing degradation of the forest resources and sand-dune formation. The main objective of this research is to explore and investigate the indigenous knowledge in using forests and trees and their relationship to culture and social knowledge in rural communities. The analyses were based on data collected from June - October 2005 in two localities in Kordofan State (Sheikan, Ummrawaba). Structured questionnaire was randomly distributed for 90 respondents between male and females as 61 % and 39 %, respectively.

The results showed that 51 % of the indigenous knowledge source is inherited and 49 % is locally acquired. Further it was shown that 13 medicinal trees (e.g. *Acacia nilotica*) were used for traditional medicinal treatments. These are used for treating about 16 human diseases (e.g. malaria, dysentery etc). People rely on forests and trees to provide them with fruits, leaves, seeds, pods, fibres and gums for their foodstuff and drinks. Ten tree species (e.g. *Boscia senegalensis*) are used by local people as famine food during drought periods. According to the cultural importance of forest, local communities use some trees in delivery (12 tree species), circumcision (10 trees species), marriage (5 trees species) and death. Some tree species (14 tree species e.g. *Adansonia digitata*) are believed to cause devil spirits if people sleep under, cut or climbed them. Other trees are used for ritual activities (religious belief) such as *Salvadora persica* used as brush tooth. During dry season, 19 tree species (e.g. *Acacia* spp.) are used as fodder for animals.

The study recommended that, local knowledge should be included in various strategies for forest conservation and management. Also, concluded that the practices of local knowledge by rural communities play positive roles in forest resource utilisation and conservation in the area.

Keywords: Forest resources, local knowledge, Sudan, rural community, tree uses

Agroforestry Systems Acceptability in Pucallpa, Peruvian Amazon

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In recent decades, accelerated rates of deforestation have caused growing environmental degradation throughout the developing countries of the tropics. The investigation was situated in Peruvian Amazon, Ucayali region, where similar problem exists; soil is deeply degraded by consequent impact of local agricultural practices. Shifting cultivation is no longer sustainable in this area and agroforestry is particularly appropriate for rehabilitating degraded land because of the multipurpose function of trees. Research was aimed at verification of proposed hypotheses related to agroforestry acceptability. The main objective was to identify factors influencing adoption of multistrata production systems by small-scale farmers and design a suitable agroforestry system in this region. Land-use systems were examined in three settlements- Antonio Raimondi, Pimental and Nueva Belén. Data were gathered through semi-structured questionnaires and interviews with local settlers. The influence of cultivation patterns of the smallholders, their crop preferences and factors such as income, labour, age of the peasants, size of household and possession of livestock was assessed in 54 households. Correlation between multistrata production system acceptability and different farming conditions was proved. Rates of reforestation and cultivation of timber trees on fields in association with other crops (goal-directed or unintentionally) are significant. Substantial number of respondents favouring agroforestry is market-oriented, with less labour available, earning less than Nuovo Sol 5000 (1 USD = Nuovo Sol 3.3) annually, not possessing livestock and having free land for disposal. Mainly young families establishing new fields and older settlers (requiring additional labour) welcome conversion to different land-use systems. There were differences among communities in multistrata system adoptability. Whereas in economically poorer village majority of households is practicing agroforestry nowadays (probable reason was soil of low agricultural quality and reduced productive capacity), in village with higher earnings, where cultivation is dedicated mostly to one market-appreciated monocropping (pepper), less importance is given to agricultural transition. As well in community where exploitation of forest products is important activity and farming is reduced, people find agroforestry methods less attractive. Crop preferences and calendar of filed work are discussed and suitable agroforestry system was designed.

Keywords: Adoption of agroforestry, incentives, multistrata production systems, small-scale farmers' preferences, socio-economic characteristics

Land Use Management in Rural Areas of the Brazilian Atlantic Forest

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The remaining areas of the Brazilian Atlantic rainforest are mostly located in small scale farms. The protection and restoration of the existing fragments of this unique biome is relying on the commitment of private landowners.

In the present research the author could identify that tobacco cultivation is the source of income of most families in rural communities located in the municipality of Atalanta, Federal State of Santa Catarina. Tobacco cultivation causes environmental impacts and human degradation. Fire wood exploitation, erosion and the contamination of soil and water have been disturbing the landscape drastically. Furthermore, it was recognised that families who are involved in tobacco cultivation have difficulties to organise their own farms and therefore securing their own sustenance. Farmers are predominantly frustrated with their current living conditions. The main reason given was the illness caused by the high amounts of pesticides used on the tobacco fields and the poverty originated from the production contracts and loans. Farmers are trapped on a cycle of dependence, associated with the tobacco companies through debts. The need to plant tobacco for paying the debts hinders the enthusiasm of farmers in embracing the environmental cause and in developing new forms of local cooperation.

In this context, since 2005, the project Planning Farmland and Landscapes has been supporting families in the reorganisation and restoration of their farms, the protection of the environment and the socio-economic development of rural communities. This was done together with the families, through the introduction of native trees and the improvement of income and life quality of farmers.

Reforestation combined with the distribution of fruit tree species was a strategy used to diversify tobacco monoculture, supply families with a free source of food as well as a new source of income. Furthermore, the author supported farmers in introducing organic agriculture for own consumption. Since then, the improvement of living conditions is being reached through a greater variety and quality of food. The next step is to support farmers for gradually developing a cooperative of organic producers and leaving the tobacco fields.

Keywords: Atlantic rainforest, environmental degradation, land use management, organic agriculture, quality of life, reforestation, tobacco cultivation

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Relationship Between Production Systems and Environmental Impacts in a Buffer Zone: Case Study in the South-Eastern Periphery of Amazonia, Maranhão State, Brazil

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This paper presents preliminary results on a socio-environmental study on agricultural and pasture landuse systems in the buffer-zone of the native Indian territory 'Alto Turi-açu' in Zé Doca county, Maranhão State, Brazil. This territory, inhabited by 1500 Indians, represents one of the last remaining areas of mature rainforest in the region which is seriously endangered by illegal wood extraction and pasture expansion. Research is part of activities of a newly developing research programme on sustainable landuse, located in the south-eastern periphery of Amazonia and composed of the M.Sc.-course in Agroecology of Maranhão State University and the Embrapa Mid-North Agriculture. Research aims at a better understanding of the relationships between landuse systems and the resulting environmental impacts. For this purpose, we applied a socioeconomic questionnaire on 15 families collecting information on plant and animal production systems, landuse and family income and farmers' expectations during the agricultural year spanning from August 2005 to July 2006. We calculated the relative technical efficiencies of production units and processed data with Data Envelopment Analysis (DEA). We relate individual benefits with the associated types of environmental impacts in this buffer-zone which historically suffered from deforestation and repeated burns. Results demonstrate that the production systems significantly impact the predominating vegetation cover. We furthermore identify a reduction in the relative technical efficiency of the production units associated with an increase in income derived from beef production together with a reduction of income derived from food crop production (upland rice, maize, beans, cassava). In conclusion we recommend a diversification of landuse systems in order to increase the efficiency of landuse.

Keywords: Agroecology, ecological economics, landscape ecology, smallholder agriculture, sustainable development, Brazil

Vulnerability and Resilience of the Cambodian Forest-Rural Interface

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This paper examines examples of vulnerability and resilience at the Cambodian rural-forest interface. Poor and rural population are often considered as the key factors for land degradation, next to exploitation of timber products, mining, and plantations which increases inherent vulnerability of the fragile ecosystem at the agricultural forest interface. A growing population and increasing consumption of forest resources for timber, fuel wood, and a range of non-timber forest products (NTFP) are placing the remaining resources under significant pressure. Demand on forest resources is growing fast as especially the rural population continues to grow rapidly in Cambodia. Traditionally, forest resources play a significant role in the household economy, as an additional source of food, but also as an important source for tools, and for medicine. As part of the degradation process, forest cover is being lost permanently as it is converted to agricultural land, often in the form of large plantations. This is facilitating a significant in-migration of settlers into former dense forest areas. Many of whom subsequently seek to clear forestland and gain title to newly cleared areas which is often followed soil degradation and inadequate land use.

The direct causes for vulnerability of Cambodian rural forest interface are land grabbing, illegal agricultural encroachment, forest and economic concessions, illegal timber and NTFP harvesting and restrictions of forest use for local communities, due to protection and biodiversity conservation. Furthermore, there are a number of underlying or indirect reasons for increasing conflicts in rural area like improved access to remote and even far remote areas and a fast growing population migration to frontier provinces. As a result, countrywide many communities are in a state of flux due to both temporary and permanent migrations. These changes have further impoverished Cambodia's rural communities. The emergent instability and vulnerability of both forest resources and rural communities points to demographic issues, poverty alleviation measures and to the character and condition of forest vegetation as key factors in determining sustainable land use practices to remain and improve environmental services to rural population in Cambodia.

Keywords: Cambodia, resilience, Rural Forest Interface, tropical forest, vulnerability

Risk in Diversifying Agricultural Land Use: Perceived Impacts of Woody Species and Livelihood Diversification Strategies in the Central Highlands of Ethiopia

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Research on sustainable land use in Ethiopia has recently been extended to locally-grown woody species outside forests. The non-competitive integration of woody species in agricultural farms may support the development of adapted land use systems by providing both goods and service functions. Thus, the control of natural resource degradation and the diversification of income, which may gain significance in livelihood diversification strategies, meet concerns of the Ministry of Agriculture about how to cope with environmental degradation and human needs within the Millennium Development Goals.

This study stresses the need for awareness towards neglected farmers' perception of potential private gains and losses from diversifying agricultural land use by integrating woody species. The objectives are (i) to identify woody species occurring in agricultural land with special respect to farm fields, (ii) to analyse the perceived suitability of woody species in terms of goods produced to diversify livelihood activities, (iii) to analyse farmers' risks perception and responses to risk in farming linked to woody species and potential service functions.

The methodology bases on the analysis of the 'Farming System'. An integrated study approach combines a rapid appraisal and formal questionnaire survey in 130 systematic-randomly selected and ex-post stratified households in two villages. The analysis of woody species diversity in agricultural land relies on key persons' local knowledge, direct observation and botanical assessment on-station. Pair-wise and direct use ranking help to identify woody species that appeared to farmers as most promising for several uses. Likert scales reveal farmers' perceptions of risk associated with woody plants on-farm and their role in responses to risks. The analysis makes use of indicators on the farmer's access to and control over resources and is based upon descriptive statistics.

Results refer to opportunities and threats in diversified tree-integrated agricultural land use corresponding to perceived strengths and weaknesses of particular woody species that (a) are competitive/non-competitive for natural resources in farm fields, (b) constitute sources of fuelwood and fodder in diversification strategies, and (c) impact the range of potential service functions - primarily the prevention of soil erosion and soil improving capability.

Keywords: Diversification strategies, Farming Systems, local knowledge, non-competitive tree integration, perceived benefits from land use, risk perception and response

Forest Tree Regeneration on Fallow Land after Shifting Cultivation in the Northwest Region, Viet Nam

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In the Northwest region of Viet Nam, agricultural land becomes increasingly limited resource. Slash-and-burn agriculture is still predominating and is one of the main factors for deforestation, land degradation and biodiversity losses due to increasing population density. Consequently, there is a large area of fallow land (about 2,000,000 ha) with low vegetation cover and species diversity. This study was conducted on fallow land at Chieng Boom commune in the Northwest region. The objective of this study was to evaluate whether forest trees can be regenerated on fallow land, by measuring the number of regenerated forest tree species and their abundance. The experimental area of 100m² per plot and random sampling method were used to collect data for the number of regenerated forest tree species and their abundance. All fallow land was divided into 4 categories, based on the number of years after fallow. Species richness, abundance and Shannon index were used to evaluate the diversity of regenerated forest tree species.

The longer the fallow period was, the more forest tree species appeared. After 15 years of fallow period, the number of regenerated forest tree species was 42, which accounts for 80 % of total species in the adjacent natural forests. Their abundance was very high, but those mainly were seedlings and saplings. The percentage of trees with DBH bigger than 6 cm was 7.2 %, equivalent to 65 trees per ha. The main part of regenerated species was pioneer species, which grew very fast at the beginning. More than 80 % of trees were regenerated from seeds and the rest from sprouting, indicating that seed is the key for the regeneration of forest trees on fallow land in this region. The seed source is mainly from mother trees which were left when shifting cultivation was conducted and adjacent natural forests, but some from seed bank in the soil.

Keywords: Fallow land, forest tree regeneration, shifting cultivation, Viet Nam

Sustainable Livelihood Examples from Water Deficient Easter Island and the Lower Amazon River Floodplains

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The Brundtland Commission definition of sustainable development (1987) is used in this assessment: “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. The United Nations Millennium Development Goals (2000) recommend a trend toward sustainable development principles in tropical regions encompassing social, cultural, economic, political and environmental components. Environmental sustainability can only be achieved through natural resources proficient utilisation, with emphasis to the ancestral formulas that have sustained human presence in fragile tropical regions along the years. In times of climate excesses it is of utmost importance to seek for indigenous livelihoods that offer evidence of viable techniques and land uses able to cope with floods and drought, as is the case with lower Amazon basin peasantries, the Caboclos, and Easter Island aboriginal Rapa Nui peoples. The main purpose of the ongoing research in Lower Amazon riverine areas is to learn how local smallholders live from the forest and by the forest. Successful examples of ethno-development persist along Amazon River margins, providing the possibility to discuss multi-functional livelihoods and multi-local biodiverse agro-forestry models. In the paradigmatic Chilean Pacific Island, a remote and poorly resource provided ecosystem, one of the most vulnerable in the world, peri-urban farmers use rainfall reservoir systems to water supply subsistence and commercial crops. The case studies are contrasting in terms of water availability however presenting similarities in livelihood systems, their creativity and adaptive nature meeting the demands of climate change and their uniqueness confronting pressing global development options.

Keywords: Easter Island, livelihoods, lower Amazon basin, resource proficiency

Effect of Environmental Factors on Productivity of *Guadua angustifolia* Stands in Coffee Region of Colombia

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In order to promote the proper utilisation and management of *Guadua angustifolia* and the productivity options available to farmers in the Colombian coffee region, information on growth and productivity of this bamboo species was obtained. This study focused on the effect of environmental factors on stand productivity. The study sites were located in the Colombian coffee region. The aim was to assess differences in the productivity of *Guadua* stands due to environmental conditions and determine which response variables are the most sensitive to specific environmental conditions. An analysis of principal components provided information for the identification of key variables responsible for most of the variability between sites.

The final environmental variables selected for the construction of predictive models was defined considering the high loadings of variables in the principal components and their higher correlation with the respective response variable. These variables were used in multiple regression models. Average culm length and stand basal area can serve as indices of *Guadua* stand productivity. Average culm hardness is useful to determine culm quality within *Guadua* stands. According to the statistics evaluated, the regression models for these variables showed a reasonable goodness of fit for culm length ($R^2 = 0.54$, $MSE = 5.3$), for stand basal area ($R^2 = 0.51$, $MSE = 411$) and for culm hardness ($R^2 = 0.51$, $MSE = 7.6$). However, the variability in the productivity and quality of *G. angustifolia* could not be entirely described by the environmental set of independent variables measured and a significant proportion of the variability remains unexplained. In addition, factors that describe culm and stand characteristics were obtained. The “growth” factor showed a larger load of dendrometric culm variables whereas the “quality” factor exhibited a larger load of physico-mechanical variables. For *Guadua* stands, the “growing stock” factor showed the strongest correlation with variables such as average diameter at breast height and average culm length. The “dynamics” factor exhibited a strong correlation with harvest intensity, percentage of shoots and percentage of young culms. The “quality” factor was strongly correlated with physical and mechanical properties, especially with average compression strength.

Keywords: *Guadua* bamboo, multivariate analyses, coffee, Colombia

Cost-Benefit Analysis of Land Use Alternatives in Malawi

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Against the background of land scarcity, prevailing poverty and increasing demand for food and fuel wood, there is a high pressure on the Miombo forest margins of the Liwonde Forest Reserve (Machinga District, Malawi). Rural livelihoods substantially rely on the exploitation of natural resources to satisfy their daily needs, and this leads -combined with lacking enforcement of legal restrictions- to unsustainable land use and land degradation with negative long-term consequences. Co-management of natural resources under participation of the forest administration and local stakeholders seems to be a promising approach for changing this situation. Our study focuses on a comparison of four land-use alternatives, two agricultural and two forestry ones, in and adjacent to the Liwonde Forest Reserve. We include biodiversity, inventory, socio-economic and political aspects and summarise our findings in a comprehensive cost-benefit analysis. Net present value and annuity are used as evaluation criteria supplemented by a sensitivity analysis of the most important variables. The results are meant to give support and background information in the co-management decision process. We conclude that agricultural land uses, such as maize or cassava, are economically attractive, thus, partly explaining pressure on forest margins. However, sustainable restoration/ management of Miombo woodlands could be a promising alternative, performing better than extensive managed eucalypt plantations used for fuel wood production in our study region. The project has been conducted and organised by students of the Master course Tropical and International Forestry of Göttingen University in cooperation with researchers from the Forest Research Institute of Malawi (Zomba).

Keywords: Forest co-management, cost-benefit analysis, Malawi

Mobility, Rural-Urban Linkages, and Land Use Change: Implications for Forest Livelihoods and Land Tenure Security in Amazonian Extractive Reserves

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This paper presents results from long term research with rubber tapper households in the Chico Mendes Extractive Reserve in Acre, Southwestern Amazonia, Brazil. The research analyses changes in land use and income composition, household turnover and migration patterns, and examines the flow of goods and services between forest and urban areas. While migration has long been part of Amazonian landscapes, mobility along a forest-urban continuum has increased significantly in the last two decades — however, in more complex ways than one-way rural exodus. Linked to rapid changes in land use and income opportunities, mobility and increased rural urban linkages present new threats to livelihood and land tenure security for forest-based smallholders and fundamentally changes the forms of territorial occupation. Nevertheless, increased rural-urban linkages also provide improved opportunities for forest product marketing in expanding and new urban centres. The research identifies a significant commercial and non-commercial flux of forest and agricultural products and capital from forest to urban areas and in return a flux of industrial products, temporary labour, and capital investment from urban to rural areas, mostly through family ties. As a result, forest peoples are increasingly linked to urban areas and in many cases hybrid forest-urban livelihoods emerge. For policy makers, regional planners, development and conservation projects, as well as social movement organisations it is important to take continued mobility and rural-urban linkages into account when addressing challenges such as land tenure security, forest income generation, and deforestation.

Keywords: Brazil, land use change, rubber

Forestry

Invited Paper	269
FERGUS L. SINCLAIR: Ecosystem services in forest and agrarian landscapes	269
Oral Presentations	270
UWE MUUSS, JOACHIM KIRCHHOFF, NETRA BHANDARI: Meeting the Growing Demand for Wood: Sustainable Plantations and Commercial Harvesting Operations in Transition Countries	270
BARBARA TAUBERT, JÜRGEN PRETZSCH: Cultural Influence of Forest Perception and Forest Use among the Tiriki Community in West Kenya	271
VALDIR MARCOS STEFENON, OLIVER GAILING, REINER FINKELDEY: Recovery and Conservation of <i>Araucaria</i> Forest in Brazil through Plantation's Establishment: A Genetic Point of View	272
Posters	273
HANS WULLAERT, EDZO VELDKAMP, MARIFE D. CORRE: Immediate Impact of Elevated Nitrogen Input on Trace Gases Emissions in an Old-Growth Lowland Forest in Panama	273
WOLDE MEKURIA: Vegetation Restoration in Area Closures: The Case of Douga Tembein, Central Tigray, Ethiopia	274
JOSÉ ISIDRO UVALLE SAUCEDA, HUMBERTO GONZÁLEZ RODRÍGUEZ, ROQUE G. RAMÍREZ LOZANO, ISRAEL CANTÚ SILVA, MARCO V. GÓMEZ MEZA: Seasonal Trends of Chlorophylls a and b and Carotenoids in Native Trees and Shrubs of Northeastern Mexico	275
HUMBERTO GONZÁLEZ RODRÍGUEZ, ISRAEL CANTÚ SILVA, ROQUE G. RAMÍREZ LOZANO, MARCO V. GÓMEZ MEZA: Litterfall Production in Semiarid Woodlands, Northeastern Mexico	276

- JAVIER JIMENEZ PEREZ, OSCAR ALBERTO AGUIRRE CALDERON, HUMBERTO GONZÁLEZ RODRÍGUEZ, MARCO AURELIO GONZALEZ TAGLE:
Restoration of Endemic Dwarf Pine (*Pinus culminicola*) Populations in North Mexico 277
- HAI NGUYEN TIEN, HOLM UIBRIG:
Forestland Management by the Hmong Ethnic Group for Sustainable Livelihood in the Northern Uplands of Viet Nam 278
- PARVIZ FATEHI, MANOOCHEHR NAMIRANIAN, ALI ASGHAR DARVISHSEFAT:
The Study of Suitable Forest Territorial Organisation in the Northern Zagros 279
- LAZARE TIA, SEBASTIAN SCHMIDTLEIN, PAUL L. G. VLEK:
Estimating and Upscaling Tree Density by Applying LAI-SEB Model to Optical Remotely Sensed Imagery within the Volta Basin (West Africa) 280
- PAUL GUTHIGA, JOHN MBURU, KARIN HOLM-MÜLLER:
Factor Influencing Local Communities' Satisfaction Levels with Different Forest Management Approaches of Kakamega Forest, Kenya 281
- JORGE HUGO GARCÍA SIERRA, MIGUEL ANGEL DOSSMAN GIL, LIGIA MARIA ARIAS GIRALDO, JUAN CARLOS CAMARGO:
Planning of *Guadua* Forest Based on Land Assessment and Site Quality 282
- ESTHER FICHTLER, MARTIN WORBES:
Climatic Signals in $\delta^{13}C$ Time Series from Tropical Tree Rings 283
- FRÉDÉRIC THOMAS, JÜRGEN POHLAN, MARC J. J. JANSSENS:
Transformation of Coffee Plantations through Tropical Timber Production in the Region of Soconusco, Chiapas, Mexico 284
- BERNARD NSIAH, JÜRGEN PRETZSCH:
The Contribution of Smallholder Forest Plantation Development to Sustainable Livelihood of Farm Households in the High Forest Zone of Ghana 285
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Ecosystem services in forest and agrarian landscapes

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Agricultural impacts in forested landscapes are a major and accelerating driver of change to ecosystem services, while tree cover in agrarian landscapes is increasingly valued as a means of enhancing their provision. Meaningful landscape units depend upon the ecosystem. Catchments are appropriate for water flow and quality but occur at a range of scales, with discontinuity of response across scales. Often catchments comprise mosaics of forest and agrarian land cover with uneven anthropogenic disturbance of forest areas and distinct forms of tree cover in agrarian areas. Habitat networks focus on the connectivity of the elements within and beyond these mosaics and are often used to evaluate biodiversity conservation options. Once again, there are discontinuous responses across scales of measurement with the appropriate scale depending upon the distances that the organisms of interest and their genes move. The state of carbon stores and fluxes in some fragile landscapes threaten wholesale regional collapse of ecology and society. Attempts to manage ecosystem services are further complicated because they interact and are traded off against one another and productive exploitation of land. Rarely does social capital exist at the same scales as these ecosystem services are manifest. This means that there is a requirement for integrated approaches that build social and natural capital simultaneously, creating institutions through which management and policy can be implemented. Current developments with model forests and corridors, at a range of scales, are beginning to address these issues but require more explicit ways of dealing with discontinuities of scale.

Keywords: Ecosystem services, modelling

Meeting the Growing Demand for Wood: Sustainable Plantations and Commercial Harvesting Operations in Transition Countries

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In 2002, world wood-production was estimated to be 2,971 million m³ plus 510 million tonnes pulp produced from the forests covering 3,868 million ha of which 187 million ha are from the plantation forest. Tropical timber accounts only for a small portion of the world trade and world timber production; however, the economies of many developing countries in the tropics rely heavily on it. Likely, roundwood production in tropical countries will increase. A significant contributor to such increase is woodfuel consumption and it is expected that the global woodfuel production increases moderately as dependency of woodfuel in developing countries is still high; most households in these countries resort to using wood as main energy source. Particularly during the last decades, the Asia-Pacific region has undergone drastic changes in wood supply and demand as emerging economies consume huge amounts of natural resources including timber while at the same time most countries experience severe forest losses and forest degradation. The major role in the region consuming vast amounts of forest resources, still originating to about two third from the Asia-Pacific region, plays China, which became and will keep its position as the leading nation in forest products demand. China's spectacular economic growth over the last decade is having a dramatic impact on the global wood and timber market and affects are not restricted to the Asian region, but have impact in Latin America and Africa as well. From 1997 to 2005, China's total forest products imports have risen from 40 to almost 150 million m³.

Plantation forestry plays a significant role for wood production in tropical countries because of its several important characteristics such as high yield per unit area, very short rotations, good accessibility, etc. Over the past 15 years, the share of industrial fibre from plantations has grown from 5 to 30 percent against native forests, for which as a whole the productivity is likely to decline. There is no doubt that the importance of plantation forestry is increasing to meet the future demands, which especially holds for many developing and transition countries. This paper elaborates on how the growing demand for wood and timber products can be met in the future in a sustainable manner. In this regard, the role of plantation forestry and commercial harvesting operations is emphasised and good practise examples are discussed such as the promising Forestry Sector Development Project for Viet Nam involving small farmers. Collaborative forest management systems are seen very promising with the aim that local communities can manage their own resources, rehabilitate and protect forests, market forest products, and benefit from security of tenure.

Keywords: Plantation forestry, sustainable utilisation of timber, timber market, wood production

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Cultural Influence of Forest Perception and Forest Use among the Tiriki Community in West Kenya

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Although globalisation is ongoing rapidly, in Kenya forests can be identified, which are managed by local people in a traditional and sustainable way. It is assumed, that the related perception of forest use is based on specific values and attitudes. The aim of this paper is to investigate intangible forest related values and attitudes of the Tiriki. The sacred community forests of the Tiriki are described as rich in biodiversity. The study investigates cultural constructs that influence the perception and use of these forests. It is investigated which role traditional and religious practices play in this context. Main emphasis is given to contemporary connections of the Tiriki and ‘their’ sacred forests. Traditional and modern intangible values are investigated to understand the importance of sacred forested places and to elucidate differences to governmentally administered forests.

Based on a case study approach the following data collection methods are being applied: review of documentary material, accompanying community members to spiritual places and activities, photographs, group discussion, semi-structured and narrative interviews. Interviews were recorded, transcribed and analysed using the software MAXqda2.

The analysis of the interviews reveals that forest related intangible values can be classified and hierarchically structured taking reference to Bagatzky (1986). On the highest level of abstract principles the common sense and the closed canopy as well as a selection of special indigenous tree species of sacred forests as cultural places can be identified. On lower levels the direct protection of the forest and related practical rules are clearly stated (e. g. who is allowed to perform which activities inside these forests). The Tiriki are known to obey their simple rules very strictly (common sense). This will be illustrated with examples.

With the further data analysis tangible indicators of culturally appropriate forest use will be derived and may be used for the formulation of guidelines for sustainable forest management.

Keywords: Traditional attitudes, cultural impact, forest use, perception, sacred forest

Recovery and Conservation of *Araucaria* Forest in Brazil through Plantation's Establishment: A Genetic Point of View

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The *Araucaria* forest is a particular ecosystem formed by an admixture of two distinct vegetations: the tropical afro-Brazilian and the temperate austro-Brazilian floras. This peculiar forest is part of the Atlantic forest domain, one of the most endangered Brazilian biomes. The dominant species in this ecosystem is the Brazilian pine (*Araucaria angustifolia*), an ecologically and economically important species in southern Brazilian highlands. Their highly nutritive seeds are appreciated by humans and animals, comprising the most important source of food during the winter in the araucaria forests. Besides, the commercialisation of these seeds constitutes a significant source of income to an undetermined number of small farmers. Although covering around 200,000 km² of the southern states of Brazil at the beginning of the 20th century, the intensive exploitation process reduced its area to about 3 % of the original forest. Brazilian pine remnants hold abundant genetic diversity. However, the protection of the species in a genetic view depends on the conservation of extant populations, promotion of connectivity among them and support of natural regeneration. Recently, it has been suggested that establishment of plantations facilitates forest regeneration in grassland faster than natural succession, encouraging its use in recuperating degraded areas.

In this study, molecular markers were used to explore patterns of changes in the original genetic structure of plantations by comparing patterns of genetic structure between plantations and natural populations of Brazilian pine. Signatures of artificial selection favouring gene(s) possibly related with plant growth through selection of seedlings used in the plantations' establishment and the maintenance of plus-trees in the stand were detected. Besides, the results suggest that remnants of Brazilian pine preserve potential to supply plant material with sufficient genetic diversity for the species conservation through plantations. Hence, establishment of plantations may considerably assist the conservation of araucaria forest in southern Brazil. Additionally, the incorporation of local knowledge and skills, as well as the rational exploitation of secondary forest products and agroforestry by local people will likely increase the success of reforestation enterprises.

Keywords: Brazilian pine, genetic resources, planted forest, species recovery

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Immediate Impact of Elevated Nitrogen Input on Trace Gases Emissions in an Old-Growth Lowland Forest in Panama

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In tropical areas, nitrogen (N) emission, transport and deposition are projected to increase rapidly in the next decades. In this study, the consequences of elevated N input on trace gases emissions from a tropical lowland forest soil were evaluated. The study site is located in Gigante Peninsula, Panama, which included control and N addition treatments each with four replicate plots. Urea-N was applied twice in 2006 (April 28 and June 6) at a rate of 31.25 kg N ha⁻¹ each application. Nitrous oxide (N₂O), nitric oxide (NO), carbon dioxide (CO₂) and methane (CH₄) fluxes were intensively measured prior to and until one month after the second N application; this measurement period was within the beginning of the rainy season. We observed significantly higher NO emissions from the N-fertilised than the control plots, but N₂O, CO₂ and CH₄ fluxes did not differ. The increased NO fluxes were largely observed during the first week after the second fertilisation, when water-filled pore space (WFPS) has increased as the rainy season progressed. N₂O emissions could possibly increase with N addition when soil moisture further increase into the rainy season. The significant correlation between N₂O + NO fluxes and NH₄⁺ levels and the range of WFPS (40–60 %) indicated that N trace gases were possibly predominantly produced by nitrification. The fertiliser- induced N oxide emission was 3 % of the applied N. The CO₂ and CH₄ fluxes indicated that initial N addition did not bring detectable change in microbial decomposition and root respiration for CO₂ emissions and in CH₄ consumption and production for CH₄ fluxes, at least during the early rainy season covered in our measurement.

Keywords: Climate change, denitrification, N cycling, nitrification, tropical lowland forest

Vegetation Restoration in Area Closures: The Case of Douga Tembein, Central Tigray, Ethiopia

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Since 1991, communities in Tigray region have started to establish area closures (ex-closures) to deal with shortage of biomass and land degradation. Although the need of scientific information is clear, studies made to assess vegetation restoration in area closures are very limited. This study assesses the population structure and biomass of two dominant woody species: *Acacia etbaica* and *Euclea racemosa* subsp. *schimperii* and compare with communities fuel wood demand. For this study contrasting age of exclosures (5 and 10) were selected. Vegetation assessment was done using systematic line plot sampling in an area of 3600 m². One way analysis of variance and regression analyses were used to analyze the data. A strong relationship was not found between the diameter and height of the two woody species in both exclosures. However, with the increase in year of protection, the relationship for *A. etbaica* gets better ($R^2 = 15.4 - 22.8\%$). This shows the improvement of sites with an increase in age of protection. The frequency distribution of woody species showed almost an inverted J-shape with few or no individuals at higher diameter classes. This could be due to selective removal of bigger woody species for fuel wood and construction. Mean density of the two woody species within treatments varied between 194 and 1078 trees ha⁻¹; basal area 1.74 and 8.7 m² ha⁻¹; volume 1.98 - 13.98 m³ ha⁻¹; live above ground biomass 3014.40 - 5268.30 kg ha⁻¹; and dry above ground biomass 359.98 - 462 kg ha⁻¹. The result showed that there is a significant difference ($P < 0.05$) in vegetation parameters investigated between the two wood species within treatments. The result also indicated that from the total of 114.6 ha of exclosures investigated, 51 tons of dry above ground biomass could be harvested. Given the current firewood consumption of 1 to 1.2 t hh⁻¹ yr⁻¹ and taking the number of households (200), the amount of dry above ground biomass produced would cover around 25% of their yearly consumption. Thus, exclosures have considerable contribution in solving shortage of biomass for fuel. Vegetation management such as pruning could help to increase vegetation growth and biomass produced.

Keywords: Ethiopia, area exclosures, fuel wood, population structure

Seasonal Trends of Chlorophylls a and b and Carotenoids in Native Trees and Shrubs of Northeastern Mexico

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For range ruminants and wildlife, native shrubs and trees that grow in the semiarid regions of northeastern Mexico are important feed resources; however, are affected by climatic conditions and probably causing differences in the concentrations of photosynthetic pigments when considering effects in space (sites) and weather (seasonality). The study was carried out with aims to quantify and compare seasonally the content of chlorophylls a and b and carotenoids (x + c) during two consecutive years in foliar tissue of native trees (T) and shrubs (S) such as *Acacia rigidula* (S), *Bumelia celastrina* (T), *Castela texana* (S), *Celtis pallida* (S), *Croton cortesianus* (S), *Forestiera angustifolia* (S), *Karwinskia humboldtiana* (S), *Lantana macropoda* (S), *Leucophyllum frutescens* (S), *Prosopis laevigata*(T), *Zanthoxylum fagara* (T). Pigment determinations were carried out in a region of the state of Nuevo León at three county (Los Ramones, China, Linares) sites, which are grouped under a similar climatic pattern. Measurements were quantified spectrophotometrically and data are shown in fresh weight (fw). With exception of the interaction year*plant of carotenoids content at Los Ramones site, all pigments were significantly different between years, seasons and between plants within years and seasons. All plants had marginal higher chlorophyll a content at Linares (overall mean = 0.79 mg g⁻¹ fw) than China (0.71) or Los Ramones (0.66) site. Chlorophyll b content followed a similar trend as chlorophyll a (0.29, 0.25 and 0.23, respectively). Marginal differences in carotenoids content, in all plants, were found among sites being the overall mean of 0.2 mg carotenoids g⁻¹ fw. Yearly and seasonal variations in plant pigments might have been related to seasonal water deficits, excessive irradiance levels during summer and extreme low temperatures in winter that could have affected leaf development and senescence.

Keywords: Carotenoids, chlorophylls a and b, native trees and shrubs, northeastern Mexico

Litterfall Production in Semiarid Woodlands, Northeastern Mexico

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Litterfall and litter decomposition are key fundamental processes in nutrient cycling of woodlands ecosystems at the Tamaulipan thornscrub of northeastern Mexico, which is characterised by a wide range of taxonomic groups exhibiting differences in growth patterns, leaf life spans, textures, growth dynamics, and phenological development. During two consecutive years (November 2004 to October 2006), monthly litterfall and their respective components were quantified at three county sites (Los Ramones, China, Linares) located at the state of Nuevo Leon. At each site, litterfall deposition was quantified in an undisturbed thornscrub experimental plot (20 m × 20 m). At each plot, seven (replications) litter traps were scattered over the entire area. Each trap covered an area of 0.16 m² (0.4 m × 0.4 m) and was placed approximately 0.3 m above the soil level to intercept litterfall. At each sampling date, the collected litter was sorted manually into the following categories: leaves, branches (<2 cm in diameter), reproductive structures (flowers, fruits and seeds), and others (unidentified, fine plant residues such as bark, pieces of insect bodies or feces). The samples were then dried to a constant weight at 65°C for 72 h. Total litterfall production was significantly higher in China (13.4 t ha⁻¹) followed by Linares (9.2 t ha⁻¹) and Los Ramones (8.9 t ha⁻¹). No significant differences were detected among sites for litterfall constituents. Leaves represented the main component varying from 6.0 to 9.2 t ha⁻¹ followed by branches that ranged from 1.0 to 2.2 Mg ha⁻¹, and reproductive structures that varied from 0.7 to 1.1 t ha⁻¹. The contribution of other litterfall components such as bark, insects feces and other debris ranged between 0.4 and 1.1 t ha⁻¹. Differences in spatial and temporal litterfall deposition among sites might be related to plant phenology, community plant structure and environmental variables such as extreme temperatures and heavy rainfall events.

Keywords: Litterfall, northeastern Mexico, Tamaulipan thornscrub, woodlands

Restoration of Endemic Dwarf Pine (*Pinus culminicola*) Populations in North Mexico

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Pinus culminicola (dwarf pine) was described by Andresen and Beaman (1961) as a new endemic species at the top of the protected area Cerro El Potosí, in Nuevo Leon, Mexico. Later, the distribution of the species as a total of 106 ha was described. In 1978 wildfires burned 34 % of dwarf pine population. During the past four decades, a reduction of the area formerly covered by dwarf pine has been observed, due to human impact involving timber extraction, and land use change for aerial navigation infrastructure. Currently, only 30 ha of fragmented dwarf pine area exist, and these include many old trees with low seed production that are subject to cattle grazing. The species is now considered endemic and is subject to special protection.

A study was established to test the effect of cattle, small mammals and elevation on the success of reforestation of an endemic dwarf pine species in North Mexico was implemented. Dwarf pine is under pressure from grazing, wildfires and human activities. We planted and monitored 2-year-old seedlings at three elevations within the natural distribution range of this species. At each elevation three treatments were established: (1) seedlings protected from cattle plus small mammals, (2) seedlings protected from cattle, and (3) seedlings with free access to cattle and small mammals. Seedling survival was ca. 50 % in (1) after four years, but there were no surviving seedlings with free access to cattle.

In conclusion, seedling survival was poor after four years for seedlings protected from cattle and small mammals, and no seedlings survived after being exposed to grazing and trampling for three to four years. Mortality was similar at all sites in spite of differences in environments and plant communities present at different elevations. After four years, surviving seedlings were still very small and thus susceptible to trampling and grazing both by cattle and small mammals. The implications for a large scale restoration programme are discussed.

Keywords: Cattle exclosure, grazing, *Pinus culminicola*, rehabilitation, restoration, seedling

Forestland Management by the Hmong Ethnic Group for Sustainable Livelihood in the Northern Uplands of Viet Nam

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The current forest policy in Viet Nam pursues to improve livelihood of rural populations. Essential tools are devolution of forest management to non-state entities and governmental programs/projects to restore the forest cover. However, conflicts over tenure and use of forestland between local people and state institutions have continued and even have been entailing.

This study is conducted to deepen understanding of the customary use and management of forestland of the Hmong ethnic group and to examine governmental reforestation programs. Arguments for policy-makers and programme implementers will be identified in favour of sustainable utilisation and management of forest land resources. The ‘Human Ecosystem’ model by Machlis et al. (1997) is adopted to conceptualise the research. A set of methods including Rapid Rural Appraisal (RRA), Land use inventory, and Forest inventory is applied to collect both qualitative and quantitative data in the selected study village and area.

Results of the study show the particularities of the customary claim for forestland and the use of forest resources as they are timber exploitation, fuelwood and NTFP collection, spiritual ceremony, etc. of the villagers in their living territory. Main uses of the variety of collected forest products are to fulfil local subsistence needs. Owing to the spiritual belief, customary tenure and rules, and traditional and non-traditional institutions the uses of forest are strictly regulated resulting in the locally designed development of forest management. The governmental Land Use Planning and Reforestation Project 661 have been planned and implemented following top-down approach by state institutions missing coordination with each other as well as compatibility with and involvement of grass root level planning. Yet, the existing conflicts over the use of forestland between villagers and the governmental policy implementers (e.g. Forest Protection Unit, Management Board of Project 661) turn out in threats for sustainable management of forest resources. It is expected that following the cycles of conflict and cooperation can harmonise the interests of the involved stakeholders channeling co-management of forestland resources for sustainable improvement of livelihood of the local population.

Keywords: Conflict cycle, customary rules, customary tenure, forest policy, forest land use, human ecosystem, subsistence

The Study of Suitable Forest Territorial Organisation in the Northern Zagros

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This study conducted for investigation on a suitable forest territorial organisation in the northern Zagros. In order to achieve the goal, “Group Decision Making” approach was used. The method used was based on “Analytic Hierarchy Process” which is one of multi-criteria decision making methods. At first, the most important effective criteria in the determination of management unit in the northern Zagros were recognised by a questionnaire. The second questionnaire was designed to determine the importance factor of each criteria to achieve the goal and choose the best alternative. The results show that eight main factors are effective in management unit determination. These factors are as below according to their importance: 1) Social acceptance, 2) The goals homogeneity in the management unit, 3) unity of the manager, 4) Using “one” forestry method in management unit, 5) Similarity of the management unit and forest stand, 6) Economical justification, 7) Physiographic and 8) Unit area. There were three main alternatives in managing Zagros forests. The results of this study show that the best choice among three alternatives is considering the family conventional territory as management unit in the northern Zagros followed by village conventional territory and watershed. Studying the family conventional ownership, as the management unit, a 3388 hectare area was surveyed in which all the conventional territory boundaries were surveyed by GPS. Then gathered the data were used as inputs for GIS. The results show that the area of this family conventional territory changes between 2.5 to 136 hectares. Conventional territory of each family consists of separated parts and the number of them changes from 1 to 7. The boundary of conventional territory follows the valleys and ridges. In exceptional cases, the large diameter and old trees separate the conventional territory. Studying the relationship between family conventional territory and factors such as slope, aspect and forest stands show that dividing the forest among the families flow some special rules from old time. It means that the forest has been divided in a way that all the families have had equal shares from the present situation.

Keywords: Conventional territory, Forest management, GIS, GPS, Iran, territorial organisation

Estimating and Upscaling Tree Density by Applying LAI-SEB Model to Optical Remotely Sensed Imagery within the Volta Basin (West Africa)

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The most common certain way to determine tree density is to count the number of tree stems per unit area, given that most of ecological estimation outputs are subject to bias, and more, to uncertainty. The primary requirement for that accurate tree density estimate is field-based tree biometric measurements. But most of the time, that method of estimation appears to be expensive, difficult and time consuming for larger areas of investigation. Therefore, our alternative option consist of predicting tree density by means of optical remote sensing imagery through the development of an appropriate cross validated multivariate regression model - named LAI-SEB Model (Leaf Area Index - Surface Energy Balance Model) - which is applied to large regions within the Volta Basin. To achieve this goal, the Aster scene of Nov. 17, 2006, pixel size 30 m is used. That satellite scene is processed according to standard methods such geometric correction using GCPs (Ground Control Points), image enhancement (histogram equalisation, atmospheric correction). Then, vegetation indexes and surfaces energy balance products such as SAVI, LAI, FPAR (Fraction of Absorbed Photosynthetically Active Radiation), Surface Albedo, Net Radiation, Absorbed Solar Radiation Flux, Sensible Heat Flux, and Latent Heat Flux are computed. For ground truthing, absolute tree density is obtained from tree biometric standard measurements based on systematic sampling method applied to quadrats of 30 m by 30 m. The mean tree density estimate in these field plots is 331.07 (\pm 3.76) tree stems ha⁻¹; the standard deviation is 250.09; the minimum is 11.00 and the maximum is 1233.00 tree stems ha⁻¹. The Partial Least Squares Regression (PLS-R) method was used to predict tree density from the above mentioned image derivates. The prediction consist of, first, establishing a multivariate regression model between dependent and independent variables at site scale, and second, using the regression model on new X-data set to predict new Y-data at regional or Volta Basin scale.

Keywords: Tree density, LAI-SEB Model, multivariate regression, remote sensing

Factor Influencing Local Communities' Satisfaction Levels with Different Forest Management Approaches of Kakamega Forest, Kenya

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Satisfaction of communities living close to forests with forest management is essential for ensuring continued support for conservation efforts. However, more often than not, community satisfaction is not systematically elicited, analysed and incorporated in conservation decisions. This study attempts to elicit levels of community satisfaction with three management approaches of Kakamega forest in Kenya and analyse factors influencing them. Three distinct management approaches are applied by three different authorities in the management of Kakamega forest: an incentive-based approach of the Forest Department, a protectionist approach of the Kenya Wildlife Service and a quasi private incentive-based approach of Quakers church mission (QCM). Data for this study was obtained from questionnaire interviews of a random sample of 361 households living within a radius of 10 km around the forest margin. The results of the study showed that the protectionist approach was ranked highest overall for its performance in forest management. Analysis of factors influencing satisfaction indicated that households are influenced by different factors in their ranking of management approaches. Educated households and those located far from market centres are likely to be dissatisfied with all the three management approaches. The location of the households from the forest margin influences negatively the satisfaction with the protectionist approach whereas land size, a proxy for durable assets, has a similar effect on the private incentive based approach of the QCM. In the conclusions, the paper indicates a number of policy implications that can enable the different authorities and their management approaches gain approval of the local communities.

Keywords: Community satisfaction, forest management approaches, Kakamega forest, Kenya, ordered probit

Planning of *Guadua* Forest Based on Land Assessment and Site Quality

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In the Colombian coffee region the woody bamboo species *Guadua angustifolia* Kunth represents an important natural resource traditionally used by farmers for many purposes such as construction, furniture and handicrafts. Due to the variety of uses the commercial value of *Guadua* culms has recently increased. Therefore, this resource has potential productive and protective functions essential for the sustainable development of this important region of Colombia.

Planning of *Guadua* bamboo forest is still a priority for government institutions responsible of giving principles for forest management. However, information collected in inventories and forest plans usually are unarticulated. Consequently, institutions can not provide a good guide to an adequate management of *Guadua* bamboo forest in the Colombian coffee region.

A general spatial decision model based on land evaluation process was developed to define potential areas for establishing *Guadua* plantations in five states of the Colombian coffee region. Thereafter, areas so called units of forest management (UFM) were defined for sixteen municipalities. To develop spatial decision model was used information from *Guadua* forest inventories and a baseline information on soils, climate conditions, geomorphology, environmental services and socioeconomic aspects. The software Arc View 3.3 and its extensions spatial analyst and 3D analyst were used. Also the extension Model Builder included within spatial analyst 2.0 provided tools to develop the model.

UFM represent areas with highest potential for establishing *Guadua* plantations. In addition, *Guadua* stands located within each nucleus were qualified in terms of productivity, quality and their potential to conform protected areas. Plans of management and strategies of marketing are now done according to the specific characteristics of nuclei.

The issues of this work are an important tool for planning *Guadua* forest and contribute to an adequate management of this natural resource in the Colombian coffee region. Also this experience could be replied in areas with fragmented forests.

Keywords: Forest planning, site quality, units of forest management

Climatic Signals in $\delta^{13}\text{C}$ Time Series from Tropical Tree Rings

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Terrestrial paleoclimatic records from tropical regions are essential to our understanding of past changes in the Earth's climatic system, equator-pole linkages, and the sensitivity of tropical regions to future climate change. While studies on stable carbon isotopes in trees from temperate zones provide manifold paleoclimatic data, tropical trees are still disregarded in this context. Therefore this study examined the variability of inter annual carbon isotopic pattern in several tree species from various tropical climates and identified the potential of these time series to serve as proxies for the reconstruction of past climatic events. Samples of nine broadleaved tree species from various tropical sites along a climatic gradient were investigated concerning their $\delta^{13}\text{C}$ values. The inter annual variability between species and sites was studied. Further the relation to precipitation time series and the potential for cross dating time series was analyzed.

Tropical tree species show a similar variability in carbon isotopic composition as temperate species. The radial distribution of carbon isotopes varied considerably between species and within trees. Local site conditions dominate the isotopic signal. Correlation between precipitation and tree ring $\delta^{13}\text{C}$ was significantly negative. The significant correlations found were even strong, independent of the humidity of the sites or the phenology of the trees. Successful cross dating of a tree ring $\delta^{13}\text{C}$ time series with annual precipitation time series highlights the potential of carbon isotope measurements for tropical tree ring analytical studies. Tropical broadleaved trees capture a carbon isotopic signal in their annual rings and can therefore be used as a source of past isotopic data.

Keywords: Cedrela, stable carbon isotopes, Swietenia, Terminalia, tree rings

Transformation of Coffee Plantations through Tropical Timber Production in the Region of Soconusco, Chiapas, Mexico

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The Soconusco, one of the most important coffee producing areas in Mexico, is passing through a transformation process due to the coffee price crisis. The transformation of the coffee agro-ecosystem by timber production is considered as a suitable and sustainable alternative, which is adapted to the fragile ecophysiological conditions of the Soconusco promontories. To document the transformation process from coffee to timber production and to advance the knowledge about the local growth rates of tropical timber species this study has been carried out between August and November 2006, on a former coffee producing farm, which is located in the vicinity of Tapachula in the Vega de los Gatos (15°01'40.5'' north latitude, 92°14'10.2'' west longitude and between 392 and 565 m.a.s.l.). The field study was carried out with four different timber species: *Acrocarpus fraxinifolius*, *Cedrela odorata*, *Swietenia humilis*, *Tectona grandis* and *Khaya senegalensis*, which were planted between 2003 and 2006. The experimental design consists in one systematic structure including five plots (32 × 88 m) measuring 12 plants each. Measurements of tree height and diameter (D.B.H.) have been realised two times, to show the growth rates and to document the changes of the ecosystem structure in horizontal and vertical distribution, as influenced by site-specific factors and time. To demonstrate the influence of ecological conditions on different tree species the biodiversity of soil cover was analyzed. Teak presents together with *Khaya* the highest potential in increasing plant height and stem diameter. The growth of *C. odorata* was not so easy. Plant biodiversity assessments were carried out, by documenting the most frequently appearing plant species on each experimental area. Biomass production of the living soil cover and litter oscillate between 5475 and 6925 gm⁻² in 4 years old forest and between 5188 and 7380 gm⁻² in one years old forest. Dicotyledons species were more dominant than monocotyledonous species and fine litter smaller than coarse litter.

Keywords: *Acrocarpus fraxinifolius*, *Cedrela odorata*, growth rates, *Khaya senegalensis*, soil cover, *Swietenia humilis*, *Tectona grandis*

The Contribution of Smallholder Forest Plantation Development to Sustainable Livelihood of Farm Households in the High Forest Zone of Ghana

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In view of the rapid expansion of farm forestry by rural farmers in Ghana, the study investigated the contribution of smallholder forest plantation development to sustainable livelihood of rural households. It identified and analysed the socio-economic conditions of the rural households' that induce their decision to establish and manage smallholder forest plantation as an alternative land use option in the face of decreasing agricultural outputs and increasing poverty in rural areas. The study was based on an enumeration of 280 households engaged in forest plantation management in the Offinso district of Ghana. Primary data was collected using semi-structured questionnaires, expert interviews, group discussions and wealth ranking, as well as observation. Data were analysed employing socio-metric and statistical software packages. The analysis began with the characterisation of the rural households based on their socio-economic conditions, benefits perceived from managing smallholder forest plantation and the livelihood system. The results indicate that changes in household livelihood priorities, favourable institutional conditions and market opportunities motivated the households to manage smallholder forest plantation on their farms. The role of forest plantation in increasing farm income and risk aversion strategies of the households was well recognised by the households. It was found out that rural households generally establish and manage smallholder forest plantation for meeting various household needs. Although there is a good chance of smallholder forest plantation management in improving the livelihood needs of rural households, thereby reducing poverty in rural areas, as well as reducing pressure on natural forest resources and conserving biodiversity, this practice also contributed in some cases to widen the gap between households with more resource endowments and those with relatively less assets.

Keywords: Alternative landuse, income generation, poverty alleviation, smallholder forest plantation development, sustainable livelihood

Conservation, environmental services and value chains in the Amazon region (GTZ, ACTO, AI, UNAMAZ)

Oral Presentations	288
RICARDO FELIX SANTANA: Environment Services and Livelihoods in Forest Areas in the Pan-Amazonian: A Comparative Study Between Brazil and Peru	288
MARIA A. ROVAYO ANDRADE, JUAN RODRÍGUEZ DILLON: Income Distribution and Redistribution in Value Chains: A Case Study of Coffee and Cocoa Small-Scale Farmer Associations in Ecuador	289
FERNANDO LOPEZ: Compensation for Ecosystem Services in the Watersheds of Rumiayacu, Mishquiyacu and Almendra, Peru	290
GLIDA GISELA HIDALGO, G. SOSA, R. CEDENO, M. GONZÁLEZ, M. GUERRA: Developing and Testing the Acceptability of Water Based Pineapple Ice Cream in the Venezuelan Amazon	291
JENNY PAOLA LIS GUTIERREZ: The Productive Chain of Rubber at the Forest Frontier in the Colombian Amazon	292
GUIDO BOLLATI HURTADO: Recuperation and Conservation of Native Fruit Species in Protected Areas, Bolivia	293
MAGALLY ACUÑA AZARTE: Water Resource Planning in the Piura River Basin	294
VIVIAN MAC-KNIGHT, ANA LUIZA MEIRELES, CARLOS EDUARDO FRICKMANN YOUNG: Opportunity Costs of Deforestation in Mato Grosso State, Brazil	295

Environment Services and Livelihoods in Forest Areas in the Pan-Amazonian: A Comparative Study Between Brazil and Peru

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The deforestation in the Pan-Amazonian is probably the most important problem among the multiple environmental problems that the Amazon abutter countries face. The forests provide two important services of global importance: The carbon sink function of standing vegetation and the sequestration of atmospheric carbon during secondary forest growth.

Payments for environmental services (PES) are frequently being proposed as a means to climate change mitigation, but little is known about its effectiveness and feasibility in practice. Integrated Evaluation (IE) is an interdisciplinary approach that could provide important information to policy makers and support decision processes. The basic idea of IE is to combine, interpret, and communicate knowledge of different scientific disciplines. Here we propose the following analytical steps for an IE of PES in the Amazon:

1. A qualitative analysis of promising areas for the payment for environmental services in Peru and Brazil with the use of the social carbon methodology.
2. Generation of scenarios for PES in the Pan-Amazonian, with a vision of integration of the Amazonian countries;

A market for carbon from avoided deforestation still depends on international negotiations in progress. However, it is necessary to develop standard baseline methodologies as well as monitoring and verification procedures. Some of these are currently being implemented in incipient experiences linked to voluntary carbon markets. The results of this study are interpreted in this context in order to provide an evaluation of the potential for PES in the Pan-Amazonian.

Keywords: Carbon market, deforestation, integrated evaluation

Income Distribution and Redistribution in Value Chains: A Case Study of Coffee and Cocoa Small-Scale Farmer Associations in Ecuador

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This study was developed by the German Technical Cooperation (GTZ) through the Programme Sustainable Management of Natural Resources (NAMARES), aiming to identify the impact on income and the modifications in value added distribution within value chains, related to coffee and cocoa produced between the years 2004 and 2006 by organised small farmers groups in Ecuador for specialty markets.

The research was accomplished through case studies in coffee and cocoa small-scale farmer organisations, which maintain collaboration agreements with GTZ. Issues, such as changes in the coffee and cocoa chain structure, impacts on the different chain's segments, possible causes of such variations and differences with conventional chains were also reviewed.

The main results correspond to the changes registered between 2004 and 2006, related to organic and fair trade coffee and organic cocoa. The main changes in the case of coffee are: value added redistribution in benefit of producers of more than 4 % for fair trade coffee, and of more than 5 % for organic coffee. In the case of organic cocoa a value added redistribution of approximately 3 % benefiting producers is registered.

Measures to foster value chains, between the years 2004 and 2006, have generated a change that especially benefits the first segment in the chain: the producers. This is due principally to the structure of and functions assumed by base organisations, related to quality management and marketing relations, replacing both intermediary and exporter chain segments. In addition, the information obtained during the investigation showed that other important elements contributing to these results are: product differentiation for specialty markets, public-private partnerships and availability of support services.

Keywords: Public-private-partnership, value chains

Compensation for Ecosystem Services in the Watersheds of Rumiycu, Mishquiyacu and Almendra, Peru

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In the San Martín Region, Northern Peru, the increasing deforestation of the mountain rainforest and inadequate land use practices generate different kinds of environmental impacts and externalities for downstream communities. The soil erosion has negative effects on the water quality and the regulation of the river dynamics. To evaluate the generation of water and sediment in the watershed sub and micro basins studied, hydrological models were developed using SWAT (Soil and Water Assessment Tool). These models allowed the identification of high risk areas for soil erosion.

The hydrological models provided necessary information to develop the mechanism of payment or compensation for ecological services, which is being developed in the Alto Mayo river basin, and pretends to establish incentives to reduce the externalities. The models enabled us to predict the effects of land use changes on the generation of externalities and determinate the effectiveness of conservation practices. Furthermore, the upper areas are established as local protected areas.

The SWAT model delimited the sub and micro basins using the digital elevation model of the area. This information was combined with land use, soil type and weather data, in order to determine the Hydrological Response Units (HRU). The HRU with the highest quantities of sediments, were given priority for establishing incentives for land use changes or for applying conservation practices.

The HRU on bare land, grassland or shrubland generally contributed more sediment to the water body, compared with primary forest or secondary vegetation with the same combination of soil type and slope. Nevertheless, there were some exceptions of primary forests that contributed more sediment to the water body, due to the influence of steep slopes and soil type.

The average contributions of sediments to the water body were lower in the watershed sub basins Avisado, Yuracyacu, and in the micro basin Urcuyacu, with values between 9.28 and 20.46 t ha⁻¹ per year. Higher values presented the watershed micro basins Mishquiyacu, Rumiycu and especially Almendra with 84.39 t ha⁻¹ per year. The probability that these sediments arrive at the water body varies between 4.2 % in the case of sub basin Avisado and 44 % in the case of the micro basin Mishquiyacu.

In the sub basin Yuracyacu, contrary to our expectations, the HRU that contributed more sediment to the water body were located in the lower part of the watershed. This can be explained because of the temporally unprotected soils in the rice cultivation, which are very susceptible to erosion. The upper parts of the watershed contributed only few sediments to the water body in spite of having high slopes in some cases. This might be due to the lack of information because of clouds and to the assumption that the higher parts are covered completely with primary forest, as well as the poor information on soil types.

Keywords: Peru, soil erosion, SWAT model

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Developing and Testing the Acceptability of Water Based Pineapple Ice Cream in the Venezuelan Amazon

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We developed water-based ice cream with added sugar, lemon juice and carboximetyl-celulosa (CMC), using pineapple (*Ananas comosus*) grown in the Community Pi-aroa of Betania of Topocho to 50 km to the North of Puerto Ayacucho-Amazonas, Venezuela. In order to develop a proposal for a product that contributes to diversify the production of a fruit plant processor that could be managed by the Pi-aroa ethnic group in the Betania community. Four product specifications were tested, varying the sugar concentration between 9 % and added 13 % with or without of 0.5 g of CMC. In order to measure the acceptability of the four product specifications we used a hedonic test involving 12 experts that judged characteristics, such as colour, taste, and texture. The results were analysed using ANOVA in order to identify significant differences between the product specifications. The formulation with the greatest acceptance was the ice cream N 3, constituted by: 54 % of Sugar Water 13 %, 32 % of Fragmentation hand grenade, 0.64 % of Lemon juice and 0.05 % of CMC.

We finally provide some recommendations as to what extent our approach can be used as a quick method to optimise product development in the context of smallholder communities and on-farm processing.

Keywords: Ice cream, Venezuela

The Productive Chain of Rubber at the Forest Frontier in the Colombian Amazon

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Within the 477 274 km² which form the hydrographical river basin of the Amazon River in Colombia, two processes of occupation of the territory (natives and colonists) have a direct relation with the production systems and the sustainability of the region. One of the productive activities that has dominated the transformation of the ecosystem is rubber extraction and processing. At first, between 1870 and 1915, this took place in the form of an uncontrolled boom. Later and starting in 1964, rubber production became a government strategy for farmers' income generation.

53 years after the implementation of this strategy we ask the following questions: Can we consider the productive chain of Amazonian rubber as a "Rural Agro-food Industry (RAI)"? Is its sustainability based on the development of collective strategies of the producing community?

Considering these questions the purpose of this paper is to analyse the multifunctional character of the chain with regard to the improvement of farmers' living conditions and as an economically and environmentally sustainable alternative to other economic activities.

We first provide a general description of the chain focusing on aspects, such as producer typologies, identification of stakeholders, social interaction, and the comparative advantages and specific risks of the natural environment. Using a series of indicators developed at CIRAD (Centre de Coopération Internationale en Recherche Agronomique pour le Développement) we then try to evaluate whether the studied chain can be classified as a RAI and to which degree its specific resources are being activated, according to the terms established by Boucher. Finally, we analyse the collective construction of the territorial sustainability and the role of the rubber producing community in this Amazonian sub-region.

It is important to underline that this study represents an attempt to understand (beyond the dynamics of production and transformation of the product) the interactions and the flows within the territory, the human factor and the environment.

Keywords: Colombia, rubber, value chain

Recuperation and Conservation of Native Fruit Species in Protected Areas, Bolivia

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The diversity of tree-fruit species in the Amazon, apart from representing the nutritional basis of native populations and rural settlers, may provide sustainable alternative income sources for rural producers. Yet, climate change and forest conversion are threatening many wild species, some of which unknown, with very high genetic diversity including resistance or tolerance towards adverse conditions.

The ongoing habitat destruction means a loss not only of phylogenetic resources, but also of local ethno-botanic knowledge of high potential for future generations.

In order to develop, utilise, and conserve these resources we initiated and accompanied a participatory process with the objective to generate, document and transfer knowledge among and between traditional and other local populations in and around protected areas.

The methods used included ecological zoning, inventories, identification and characterisation, key species evaluation, regeneration management, species censuses of home garden collections as well as documentation and communication activities.

166 species from 35 botanic families were identified. 151 of these are native species, but only 15 are traditionally cultivated. The classification of the study sites lead to the identification of micro biodiversity centres, in which we develop participatory *in situ* conservation strategies.

We finally assess the potential and limitations a regional scaling-up of our approach to conserve and add value to biodiversity in the Amazon region.

Keywords: Bolivia, *in situ* conservation

Water Resource Planning in the Piura River Basin

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This article presents the results of a simulation of the Poechos reservoir and proposes a framework for water resource planning in the Piura river basin.

Peru, with the exception of the Amazon region, is a country with scarce water resources and conditions of extreme dryness. This implies that water has a high economic value and sometimes generates conflicts of interest and competition between different geographical areas and stakeholder groups. Its multiple competitive uses and importance for the agricultural and other sectors mean that the rational use of the water constitutes the basis of sustainable development.

The objective of this study is to develop a conceptual framework, which allows for suitable management of the water resource in the Piura river basin. The study follows four main steps. First, it reviews the information and data available in local and regional data bases. Second, it analyses water demand and supply, which is the precondition for the third step of developing the regional water balance. Finally, the AQUANET model is applied to optimise water flows in the area.

The ACQUANET model of flow networks is used to develop scenarios of sustainable development that account for the main water uses in the study area, i.e. population, the agricultural and energy sector, and protected areas among others.

The reservoir simulation shows that the available water resources in the Poechos reservoir do not represent a restriction for water demand during the studied period.

Recommendations are provided with regard to the optimisation of water flows in the study region.

Keywords: ACQUANET, Peru, simulation model

Opportunity Costs of Deforestation in Mato Grosso State, Brazil

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The Amazon Forest possesses a biodiversity of incalculable worth, sheltering hundreds of indigenous populations and regulating national and global climate. Even though deforestation has been decreasing in the last couple of years it is still above a tolerable level. Mato Grosso is the biggest soybean producer among the Amazonian states, which is why the agricultural frontier is rapidly expanding into the rainforest. A system of environmental services payment can be a good complement of existing command and control mechanisms to slow down deforestation.

The general objective of this work is to estimate the opportunity cost of land in strategic regions under the highest pressure. The specific objective is to analyse the abatement cost per ton of carbon emitted by deforestation from soybean production, and to identify potential beneficiaries of the services provided by the forest.

Data utilised in this work was made available by local institutions. According to national accounts the value added by farming is 10.7%. Based on this it is possible to estimate the cost of opportunity of the land in Mato Grosso. To calculate emissions and the abatement cost per ton of carbon from soybean production, the deforestation is initially estimated. Once the deforestation, emissions and land profitability are known, the abatement cost of emitted carbon is estimated.

The expected result is to confirm the economic viability of projects for environmental service payments to preserve the Amazonian forest. Additionally, it is expected that the abatement cost of carbon emitted by soybean production is equal or less the price of carbon on the international markets. This way, there will be a variety of national or global solutions to stop deforestation in the Amazonian.

Keywords: Brazil, deforestation, opportunity costs

Ecosystem services in forest and agrarian landscapes

a)	Biofuels	299
b)	Scientific basis of ecosystem services	313
c)	Assessment and valuation of ecosystem services	319
d)	Institutions and management of ecosystem services	331
e)	Trade-off between conservation and development goals	345

Biofuels

Oral Presentations	301
MANFRED ZELLER, MARTIN GRASS: Prospects and Challenges of Biofuels in Developing Countries	301
TAMARA SOYKA, CHARLES PALMER, STEFANIE ENGEL: The Impacts of Tropical Biofuel Production on Land Use	302
NILS BERGER, ARLETE MORAES: Neglected Native Oil Crops as Sources for Biodiesel Production in the Eastern Amazon Region of Brazil, Western Pará State	303
BARBARA M. E. DANNENMANN, CHALATHON CHOOCHAROEN, WOLFRAM SPREER, MARCUS NAGLE, ANDREAS NEEF, JOACHIM MUELLER: The Potential of Bamboo from Northern Laos as a Source of Renewable Energy	304
Posters	305
ALETHEIA FERREIRA DA CRUZ, ALCIDO ELENOR WANDER, RENATO PINTO DA SILVA JUNIOR: Economic Viability of Biogas Plant Use in Pig Production in Brazilian States of Minas Gerais and Goiás	305
SIMEON OLATAYO JEKAYINFA, VOLKHARD SCHOLZ: Assessment of Availability and Cost of Energetically Usable Crop Residues in Nigeria	306
SHYAM PARIYAR, SEBASTIAN WULF, JOACHIM CLEMENS: Influence of Enzyme Addition and Substrate Loading on the Efficiency of Biogas Production	307
TIL FEIKE, KEVIN WEIS, WILHELM CLAUPEIN, JOACHIM MUELLER: Propagation of Physic Nut (<i>Jatropha curcas</i> L.) on Leyte Island, Philippines	308
MARCUS NAGLE, KENNEDY HABASIMBI, HERMANN LEIS, BUSARAKORN MAHAYOTHEE, METHINEE HAEWSUNGCHAROEN, JOACHIM MUELLER: Availability and Potential of Local Biomass Resources as Fuel for Drying of Tropical Fruits	309

BLANKA KRIVANKOVA, ZBYNEK POLESNY, BOHDAN LOJKA, JANA LOJKOVA, JAN BANOUT, DANIEL PREININGER: Sacha Inchi (<i>Plukenetia volubilis</i>, <i>Euphorbiaceae</i>): A Promising Oilseed Crop from Peruvian Amazon	310
NILS BERGER: Low Cost Biodiesel Production Technology for Rural Regions	311
RAGHU CHALIGANTI, SUHAS P. WANI: Sustainable Rural Livelihoods and Urban Environment: an Assessment of Biofuel Promotion in Andhra Pradesh, India	312

Prospects and Challenges of Biofuels in Developing Countries

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Two driving forces of global change will have a decisive influence on the future of world's agriculture and forestry, and therefore on poverty reduction, the environment and last, but not least, economic growth in developing countries. These are: the ongoing climate change, and our increasingly pressing need to switch to renewable, i.e. sustainable energy. Progress towards substituting fossil with renewable energy will mitigate the risk of climate change. One principal source of future renewable energy will come from biomass, apart from wind, solar, water, and a few other sources. In this paper, we focus on biomass from agriculture and forestry. The objective is to review the current situation and likely future trends in developed and developing countries concerning the production of biofuels, i.e. energy produced from biomass. Biofuels hold a number of prospects, but also challenges, especially for developing countries. We provide a review of these potentials and challenges, and conclude that the production and use of biofuels in developed and developing countries can potentially provide a win-win-win proposal for economic growth, poverty reduction and environmental sustainability if appropriate policies and related institutional and technological innovations are promoted. Yet, biofuels also pose important challenges, which we identify and elaborate on, most importantly the exclusion of smallholders in producing biomass for biofuels, the issue of food security and rising food prices in global and local markets. We conclude that — in order to master the challenges and capitalize on the prospects of biofuels for sustainable development — massive investments in agricultural research and appropriate institutional and policy frameworks are required. While food and energy markets and therefore prices were somewhat weakly connected during the past two centuries of industrial revolution depending on fossil fuels, the link between food and energy prices will grow again in strength in the future.

Keywords: Biofuel, climate change, development policy, millenium development goals

The Impacts of Tropical Biofuel Production on Land Use

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In the context of climate change and global dependence on fossil fuels, the importance of biofuels as a sustainable alternative has been increasing in recent years. Targets for biofuels have been introduced all over the world. Meanwhile, the pressure on agricultural land increases. Due to favourable natural conditions, in the future, the largest percentage of biofuels will be produced in tropical countries. The production increase of biofuel feedstock can threaten forests as deforestation is one possible way out of agricultural land scarcity. The question arises if it is possible to increase tropical biofuel production without leading to increased deforestation. Further interests are through which channels the increasing biofuel demand affects the forest and what the direct and indirect effects of the increased production are. The research focus lies on Indonesia, producing mainly palm oil based biodiesel.

The research questions are examined with a two level approach. First, the application of a scenario analysis highlights the effects the increased palm oil production has at the household level. This method is based on literature research and results gained by the application of the economic household model for perfect markets described by Sadoulet and de Janvry (1995). Second, the impacts of increased biofuel production are considered at the national level. This analysis is conducted with a system analysis adapted from Vester (2002).

The results show that increasing demand for land and increasing prices for agricultural products and palm oil are the most important direct effects. Palm oil production area, prices of agricultural products, revenue from palm oil production and the education level are channels that influence deforestation most directly. Under the current political, institutional and economic circumstances in Indonesia, palm oil production encourages deforestation what refutes the main research question. If, in the long term, Indonesia could create more stable conditions with strictly limited forest conversion, plantation establishment on fallow land and compulsory sustainable production, the approval of the research question rises. The short- to medium- term impacts show the need for internationally binding policies between biofuel producing and consuming countries to avoid further major social, environmental and economic long-term problems in biofuel producing countries.

Keywords: Biofuels, palm oil, Indonesia, land use, system analysis, scenario analysis, household model

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Neglected Native Oil Crops as Sources for Biodiesel Production in the Eastern Amazon Region of Brazil, Western Pará State

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The Brazilian Amazon Region shelters a large amount of more or less neglected oil crops, fairly known by local land populations. Some of these are high oleaginous, with varied oil concentrations, which could serve in near future to support the growing Brazilian Biodiesel market with enough raw materials to accomplish the 2 % mixture target with conventional Diesel set by the end of 2007. These crops indeed don't serve only for energy supply purposes, which would be a cheap sell out of this raw material. High oleic acid oils are well suited as well for cosmetic and/or medical uses and appear recently in large national cosmetic brands. The research team of the CEULS / ULBRA in Santarém (Pará state, Brazil) made between 2005 and 2006 a large biodiversity survey in the western Pará state region, along the municipalities of Santarém, Belterra, Uruará, Placas and Rurópolis and along the hydrographic basins of the Tapajós and Arapiúns Rivers, between geographical coordinates of W054°37'10,40" and W056°30'46,57", S02°24'57" and S04°15'48" covering an area the size of approximately 36,000 square kilometers. During the survey mainly specimens of Arecaceae were targeted, being tucumã (*Astrocaryum aculeatum*) with 22 % the most common species, followed by Inajá (*Attalea maripa*) (18 %), babassu (*Attalea speciosa*) (11 %), bacaba (*Oenocarpus bataua* Mart.) (10 %), Assai (*Euterpe oleraceae*) (8 %) and Coco curua (*Attalea microcarpa*) (7 %) amongst other eight species. The main oil crops belonging to other species families were Brazil-nut (*Bertolletia excelsa*) and Piquia (*Caryocar villosum*) with frequencies of 10 % and 2 %, respectively. These results may give support to regional development policies concerning the Brazilian national aim to become a global player in regenerative energy forms.

Keywords: Biodiesel, Brazil, eastern Amazon, oil crops

The Potential of Bamboo from Northern Laos as a Source of Renewable Energy

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In Southeast Asia, large areas of land are covered with bamboo-dominated secondary vegetation as a result of fallow-based crop rotation, with frequent slash and burn activity. Regarded as a weed in forestry practice, the potential of bamboo biomass as a source of renewable energy tends to be underestimated. Increasing living standards and industrialisation in Southeast Asia have created a high demand for energy. For sustainable development, this demand should be covered at least in part by renewable energy sources. Charcoal from bamboo is considered a CO₂ neutral source of energy and presents a new potential export product for Laos.

In Laos, bamboo is widely used as a construction material for houses, fences and handicrafts, the fresh leaves are fed to cattle and shoots are used in local cuisine. Native people are able to distinguish different species of bamboo and attribute them with special properties, deeming them appropriate for different purposes. Despite its many uses and its irreplaceable importance in the every day life of people in Laos, its abundance makes it a non-marketable resource. Local communities regulate the fallow management to some extent and certain areas are left to bamboo growth. However, no regulations about cutting and use of bamboo exist.

In this study a compilation of indigenous knowledge of bamboo species and their uses, as well as a botanical classification of the most abundant bamboo species are given. Information on abundance and preferred sites was also documented. The various species were analysed with respect to their growth and biomass production. Length and wall thickness were measured for single culms. Total fresh biomass was determined for complete stands of bamboo. Samples were analysed as regards their chemical composition and fuel properties including calorific value. Biomass of bamboo in areas with a known period of fallow was measured to assess the temporal growth potential.

Based on the presented data, recommendations for field measurements can be given that are essential to assess the overall potential of bamboo. The combination of indigenous knowledge with field measurements and laboratory analyses as an innovative methodology can be applied to other biomass assessment problems.

Keywords: Biomass, charcoal, local knowledge, renewable energy

Economic Viability of Biogas Plant Use in Pig Production in Brazilian States of Minas Gerais and Goiás

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The modern pig production chain delivers the most consumed meat type worldwide. During several decades, the economic profits of the activity was more important than the related environmental issues. From the nineties on the environmental impacts of the swine manure became more evident. Actors of the chain were challenged to adjust their production systems due to the negative externalities. Swine manure was endangering the sustainability of the activity in the long run. Thus, the adoption of new treatment forms of manure became compulsory to reduce environmental impacts and to sustain the activity in the involved enterprises. Among the different treatment forms of manure, this study proposed the adoption of biogas plants of the Canadian Type and the use of their byproducts as to enable environmental adjusts and increase income of the pig producing farmers. Three systems were analyzed: (1) system located in Uberlândia (Minas Gerais State), with biogas use for thermic energy and combustion, as well as for carbon credits generation; (2) system located in Rio Verde (Goiás State), with generation of carbon credits, without farmers' investment; and (3) again the system in Rio Verde simulating farmers' investment. The main objective was to assess the economic viability of each system. At the end three different studies were considered, using net present value, internal rate of return, benefit-cost-ratio and payback period. Considering these methods, all considered systems were viable and economically attractive. The best economic performance was obtained with the Uberlândia system, influenced by the effective use of byproducts generated at the biogas plant.

Keywords: Biogas plants, economic viability, pig production, swine manure

Assessment of Availability and Cost of Energetically Usable Crop Residues in Nigeria

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With the ever increasing market demand for agricultural products in Nigeria, most of the agricultural residues are often allowed to rot away or not efficiently used. It has therefore become necessary to carry out an assessment study of crop residues availability in the country. Assessment of available crop residues is helpful in revealing its status and helps in taking conservation measures and ensures a sustained supply to meet the energy demand. It is also necessary to estimate the costs of various operations performed in making the residues energetically available.

An assessment of the potential availability of selected residues from maize, cassava, millet, plantain, groundnuts, sorghum, oil palm, palm kernel and cowpeas for possible conversion to renewable energy in Nigeria has been made. An attempt was also made to estimate the costs of these selected crop residues in Nigerian context. It is estimated that nearly 58 million tonnes of these residues were potentially available in the year 2004 with a primary energy potential of about 21 million tonnes oil equivalent. The residue availability for 2010 is projected to be about 80 million tonnes. These residues, when converted to energetically usable forms, can complement the existing fossil energy sources in Nigeria by more than 80 %. The cost estimates for the production of these wastes vary from US \$ 1.00 per tonne to US \$ 2.74 per tonne, depending on the farm residue and the transportation distance. This paper has provided baseline data necessary for future planning in the use of renewable energy sources in Nigeria's energy sector.

Keywords: Agricultural residues, Nigeria, production cost, renewable energy

Influence of Enzyme Addition and Substrate Loading on the Efficiency of Biogas Production

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Biogas from the fermentation of slurry is often used for the local supply of energy in developing countries. Fossil energy sources are substituted and therefore greenhouse gas emissions are reduced. Harvesting residues or energy crops can be added to fermentation in order to increase gas yields but the fermentation process might be limited by the hydrolysis of cellulose and hemicellulose, which is a pre-requisite for the production of acetic acid as it is the substrate for methanogenic bacteria. It is discussed, whether the addition of enzymes to biogas digestors can increase the biogas yield. In our experiment enzymes are tested which can also be produced on local level in developing countries.

12 anaerobic digestors (V=8 l) are continuously fed with different co-substrates (maize silage, rye silage and grass silage). To each of the substrates either active or inactivated enzymes are added with 2 repetitions per treatment. Substrates and enzymes are added daily and fermentation residues are removed. The substrate loading is successively increased in order to determine the effect of substrate availability on the efficiency of enzyme addition. Gas production and gas quality is determined daily and frequently samples are taken for determination of residue parameters (e.g. COD, buffer capacity, VFA).

Results showed that the increasing loading of oDM per liter per day indicate an increase of biogas production but the substrate loading to methane transformation ratio was decreased accordingly. Increase in oDM loading through co-fermentation with slurry is not only a cost effective alternative to composting but also increased yields in biogas production, thus contributing in the production of regenerative energy and reduction of green house gas emissions. The use of enzyme in the anaerobic digestion stabilises the fermentation process although no effect could be found in maize and rye silage as co-substrates. No enzyme effect was found under experimental condition but a transient effect was noticed at higher loading only in grass as co-substrate.

Keywords: Co-substrates, co-fermentation, enzyme, methane, biogas

Propagation of Physic Nut (*Jatropha curcas* L.) on Leyte Island, Philippines

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Due to an increasing demand for energy and lacking energetic resources, biofuels are worldwide more and more recognised as an alternative source of energy. Physic nut (*Jatropha curcas* L.) is a common plant in the Philippines, which is so far not cultivated on large scale. Its seeds contain approximately 30 % of oil. It is drought resistant and can grow on poor soils.

On Leyte Island a propagation trial with physic nut was conducted. Seeds and cuttings collected at three different places on the island were propagated under different treatments. The substrate was varied, different pre-treatments were tested and cuttings were obtained from different stem parts. The choice of the stem part had the strongest influence. Distal cuttings produced most biomass. Biomass production also varied between plant material originating from different locations. The variation in substrate didn't show an effect, same as the treatment of cuttings with a hormone solution. Plants of seeds that had been soaked in water before planting showed the highest survival rate. Anyway the survival rate of generatively propagated plants was fairly low with less than 30 %.

To find out more about the low germination rate, which was expected to be the main reason for the little success of generative propagation, a germination test was conducted. Two factors were tested: "Storage time" of seeds and "degree of ripeness" of fruits. Storing the seeds for 20 days after harvest led to an increase in germination rate from 1 % to 92 %. The older the fruits the seeds were obtained of, the lower the germination rate. The analysis of chemical composition of seeds from Leyte showed slightly higher oil contents compared to the results of seed analysis reported in literature. Farmers on the island started to cultivate physic nut recently. The soils of the physic nut fields are quite heavy and tend to water logging, which has to be seen critically. The practised intercropping technique with coconut (*Cocos nucifera*) and sweet potato (*Ipomoea batatas*) can increase benefits and minimise risk.

Keywords: Biofuel, germination, *Jatropha curcas*, propagation

Availability and Potential of Local Biomass Resources as Fuel for Drying of Tropical Fruits

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The Thai economy is highly dependent on agricultural exports, including dried fruits requiring large amounts of energy for processing. The main drying technology used in Thailand so far is the bulk convection dryer operated with petroleum fuel. Small-scale farmers relying on these dryers are being impaired by fuel consumption and the increasing operational costs resulting from soaring oil prices. Renewable energy has recently received increased attention from the Thai government with some promising potential. Biomass is a locally abundant renewable resource, a supply of which for fueling the dryers would be already available from production and processing of the fruits. Organic materials such as wood, seeds, kernels, peels and shells are currently under utilised and could provide a sustainable source of energy. However, the combustion of these resources on a large scale requires that their availability and fuel properties should first be known. Currently, little information exists concerning the potential and characteristics of mango, litchi and longan biomass resources.

The objective of this study was to investigate wood and processing residues of mango, litchi and longan and their potential as energy sources in terms of availability and fuel properties. Structured interviews as well as laboratory analyses of physical and chemical properties of collected samples were conducted. Analyses included moisture, ash, lignin, fixed carbon, volatile and calorific contents, as well as density. The results showed that the studied biomass is widely available, but there is some concern about discrepancies between source and sink locations. Regarding fuel properties, many of the analysed samples had promising potential. Longan wood showed the maximum heating value, due to its high density. Mango wood provided similar values resulting from high energy content of the bark. Mango endocarp was the residue with the greatest heating value, which was related to the high lignin content. Seed and peel samples had lower energy contents, but were still considered adequate to use as renewable energy sources for heating of drying air. Results of the other analyses are given and the potentials for combustion of these biomass resources on a large scale as related to fuel properties are presented.

Keywords: Fuel properties, litchi, longan, mango, renewable energy, Thailand

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Sacha Inchi (*Plukenetia volubilis*, *Euphorbiaceae*): A Promising Oilseed Crop from Peruvian Amazon

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Amazonia is considered the world's most important centre of biodiversity. Several important crops for world agriculture (e.g. cassava, pineapple, cocoa, rubber) were first domesticated in this area. However, numerous underexploited Amazonian plant species with promising economic value still remain little-known and neglected by science. Typical example of such species is 'sacha inchi' (*Plukenetia volubilis*, *Euphorbiaceae*). Sacha inchi is a potential new crop indigenous to the high-altitude rain forests of the Andean region of South America nowadays spreaded to the lowlands of Peruvian Amazon. It is a semi perennial, semi woody twining vine yielding mostly tetra-lobular capsules, with 4 lenticular oleaginous seeds inside. The plant has probably been used by pre-Incas and the Incas 3000 years ago which is evident from the interpretation of the plant on vessels in Inca tombs. Chancas Indians and other tribal groups of the region extract oil from the seeds which is used for the preparation of various meals. Roasted seeds and cooked leaves are also an important component of their diets. The sachu inchi seeds are rich in oil (35–60 %) and protein (27 %) content. The oil contains high levels of unsaturated fatty acids (linoleic, linolenic) and is rich in vitamins A and E. According to the properties mentioned above 'sacha inchi' is ideal for improving children alimentation and very desirable for recuperation after diseases and especially for aged persons alimentation. Furthermore, the leaves of 'sacha inchi' are considered as excellent forage. Although the composition and properties of 'sacha inchi' seeds are relatively well known, to date there is a lack of detailed information about traditional uses, cultivation, processing, economic potential and genetic diversity within this species. Intensive research on this species can contribute to future implementation of sachu inchi into the agricultural systems of the region as alternative crop which can reduce local farmers' dependence on cultivation of coca. Aim of this paper is to introduce sachu inchi plant and analyse its cultivation potential in Peruvian Amazon.

Keywords: Cultivation, oilseed crops, Peru, *Plukenetia volubilis*, sachu inchi

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Low Cost Biodiesel Production Technology for Rural Regions

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In plain 21st century constant energy supply is still a problem in some global regions, like rural communities along the Amazon river plains. These plains, inhabited mainly by small-scale landholders get their energy needs from old power generators run by Diesel during few hours per day. This not renewable fuel could easily be substituted by “green” Biodiesel produced from local oil crops. Biodiesel is chemically an ester, a chemical reaction product of an oil with, usually, a short chain alcohol like methanol or ethanol. These esters are chemically similar to petroleum Diesel and may substitute the latter in near future. Nowadays some governments like the Brazilian aim to reduce gradually the Diesel consumption by mixing Biodiesel in growing amounts to conventional Diesel, i.e. 2vol. % by end of 2007 (B2), and fully (B100) in the next 20 years. The Biodiesel production process demanding alcohol for the reaction is difficult to accomplish when adequate alcohol supply is a lack in the region of Biodiesel demand. In this case other technologies must be found to be able to produce Biodiesel with alcohol use like thermal separation of the oil compounds or “cracking”. The development of such a portable Biodiesel reactor using a catalytic vegetable oil cracking technology is done in the science laboratories of the CEULS/ULBRA in Santarém, adapting known technologies to local conditions in the eastern Para state region of Brazil. Oils of regional oil crops are used for the trials targeting using different temperature ranges for the thermal separation of oil compounds in a continuous process. The so produced Biodiesel could help small rural villages to produce their own fuel to feed the energy generators reducing fuel transportation costs for conventional, petroleum based Diesel.

Keywords: Biodiesel, Brazil, catalysis, oil-cracking reactor, Santarém, western Amazon

Sustainable Rural Livelihoods and Urban Environment: an Assessment of Biofuel Promotion in Andhra Pradesh, India

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Biofuel plantations are considered as one of the options to rehabilitate degraded lands and to enhance employment generation for the rural poor in India. The state government of Andhra Pradesh implements a programme for the production of biofuel from *Jatropha curcas* and *Pongamia pinnate* plantations in rain deficient areas.

The objectives of this study are a) to examine the biofuel policy environment, map the involved institutions and analyse their role in the implementation of the bio-fuel programme b) to conduct an impact assessment of the programme on securing rural livelihoods, improving urban environment and energy security.

For empirical evidence, a model plantation on a 300 ha common property was selected. Both primary and secondary data for the quantitative and qualitative analysis were collected.

The findings show that although 100–130 days of guaranteed employment could be provided, the involved poor households could not cross the poverty line. For example, their microfinance schemes were confined at subsistence levels to plantation and seed activities resulting in low incomes. High income economic activities need promotion of technology skills improvement in infrastructure and marketing facilities. Concerning property rights and ownership of assets by the poor, it is highly necessary that the usufruct rights provided are bundled with other promotion activities such as free from tax payment, long term use guarantee and compensation rights for land.

Most importantly, this programme has high potentialities to positively influence the urban environment of Hyderabad city. About 3000 buses operate in the city as a major public transport system consuming only fossil fuel and thus being one of the major pollution sources. Close studies of the trials run by the Road Transport Corporation of Hyderabad for six months with 20 % biofuel mix have shown very positive results. There is also a high scope to integrate carbon credit programmes of international agencies as there is no net addition of CO₂ to the atmosphere due to bio-diesel use. Further, long term comprehensive policies, institutional innovation and improved governance structures at village level play an important role to reduce rural-urban migration in order to more effectively contribute to poverty alleviation.

Keywords: Biofuel plantation, institutional arrangement, land degradation, poverty alleviation

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Scientific basis of ecosystem services

Oral Presentations	314
GEMEDO DALLE, SIMON SHIBRU: Species Richness and Conservation Status of Some Ecologically and Economically Important Species in Sheko Forest, Ethiopia	314
JUAN CARLOS LASO BAYAS, CARSTEN MAROHN, GERD DERCON, SONYA DEWI, ANDREE EKADINATA, LAXMAN JOSHI, MEINE VAN NOORDWIJK, UWE MEYER, GEORG CADISCH: Assessment of Physical Mitigation Provided by Tree Crops in the December, 2004 Tsunami Event in West Aceh-Indonesia	315
TORSTEN SPRENGER: Steps from Single Use Plantation to Multiple Use Production Areas: A Strategic Forest Management Combining Economic Demands with Social- and Ecosystem Services on Hainan Island, China	316
UDO NEHREN, JÜRGEN HEINRICH: Landscape History and Degradation in the Serra Dos Órgãos, Brazil	317

Species Richness and Conservation Status of Some Ecologically and Economically Important Species in Sheko Forest, Ethiopia

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The major land cover types in Sheko Natural Forest were forest, agriculture, pasture and settlement whereas the main use types were logging (traditional), grazing of livestock, and clearance for agriculture and honey production. Sheko forest was diversified natural forest, which should be considered as one of the biodiversity conservation centre in general and the forest genetic resources conservation in particular. The forest has floristic richness of about 66 woody species all belonging to 50 genera and 25 families. The total density of tree and shrub species is 1304 stems ha⁻¹ and density of species over 10 cm dbh (373 per ha) was low as compared to normal density of 600 stems per ha. In addition to this it is an important area as water catchments for the lower areas and the tributaries of Abay and Baro Rivers. Furthermore, Sheko forest is among the remnant natural forests in Ethiopia where wild coffee (*Coffea arabica*) grows naturally. Due to these facts the main conservation strategy should consider the conservation of the existing woody vegetation *in-situ*. This helps to conserve the gene pool of the species under threat and maintain original plant community with large species diversity.

A systematic sampling design was followed to collect vegetation data from a total of 45 sample plots distributed along three transects that were laid systematically. The distribution of transects were made in such a way that all aspects of the forest area could be covered. Some economically and ecologically important species had population structures that show abnormal patterns with no or few individuals at lower size classes. For example, *Albizia gummifera*, *Sapium ellipticum*, *Celtis gomphophylla*, *Marigaritaria discoidea*, *Deinbollia kilimandaschrica* and *Dombeya torrida*. *Croton macrostachyus*, *Olea capensis*, *Blighia unijugata*, *Pouteria adolfi-friederici*, *Albizia grandibracteata*, *Manilkara butugi*, *Celtis zenkeri*, *Trilepsium madagascariense*, *Morus mesozygia* and *Polyscias fulva* were represented by a U-shaped population pattern. There is therefore a need to develop and implement effective forest management activities in the area to facilitate healthy regeneration and eventually guarantee the sustainable use of these species.

Keywords: Biodiversity conservation, forest management, *in-situ*, regeneration

Assessment of Physical Mitigation Provided by Tree Crops in the December, 2004 Tsunami Event in West Aceh-Indonesia

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Post-Tsunami call's for establishing or improving coastal protection has been quick and loud, as presence of live barriers could probably have reduced loss of many human lives. Effective coastal zone management has to provide environmental protection but also has to meet economic targets by providing sustainable livelihood options. Tree crops and in particular trees preferred by farmers contribute to both objectives. Before the Tsunami event, 40–60 % of the economy of West-Aceh, Sumatra (Indonesia) depended on tree crops. The present study aims to assess and understand the physical mitigation provided by these tree crops in the Tsunami event of 2004 in the Aceh Barat District. High and low resolution satellite images from periods before and after the Tsunami event (December 26, 2004) are used to identify transects perpendicular to the coast line and characterised by common and distinctive landcover sequences. The tools used for gathering field information for ground-truthing are focal groups and semi-structured interviews. The emphasis is laid on data collection of damage inflicted by the giant wave and backwash effects inland. This last information is derived from estimations on flooded area, run-up height, loss of human lives, infrastructural damage and loss of arable land. Pre-conditions to develop the study include similar coastal orientation, homogeneous topographic features, distance to rivers as well as soil characteristics. Depths from the near-shore seabed are neglected since bathymetrical maps for the zone show no appreciable differences. The distance from the epicentre is also neglected due to the proximity of transects to each other. The data obtained will be used to develop correlational case studies and if possible a replicable statistical model of the influence of land use types on the mitigation of the Tsunami, especially the mitigation provided by tree crops present in the area. Preliminary investigations shows contradictory results regarding the importance of tree crops in the mitigation of Tsunami event.

Keywords: Aceh, ecosystem services, mitigation, remote sensing, tree crops, tsunami

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Steps from Single Use Plantation to Multiple Use Production Areas: A Strategic Forest Management Combining Economic Demands with Social- and Ecosystem Services on Hainan Island, China

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In China, the demand for biomass is growing rapidly. FAO (2005) reports an increase in forest cover from 157 million ha 1990 to 197 million ha in 2005 (21.2 % land cover). It is meanwhile the land with the largest plantations worldwide. The expressed target is a 29 % forest land cover in 2050. However, parallel to this increase the land suitable for agriculture and forestry decreases due to land degradation, desertification and the expansion of cities and industries. Additionally the relative economic importance of agriculture and forestry is currently declining (12 % BIP). However, 800 million people are still living in the countryside, and 50 % of them do directly depend on agriculture and its products. This derives a clear need for a sustainable optimisation of agricultural and forest productive areas. A multiple-use forest can offer beside its environmental protection services alternatives for income and prevent rural migration. Hainan Island takes part in an EcoProvince initiative of the Chinese government, focussing on issues such as biodiversity and combating desertification. In this context multiple-use forest management appears as a suitable instrument. The following points need to be researched into and optimised:

- specification of indigenous tree species suitable for plantation forestry;
- plantation conversion;
- strengthening additional forest services and biodiversity;
- a sustainable and simultaneous use of wood, Non Timber Forest Products (NTFP) and social services;
- opening up possibilities for income and viability for the local rural poor.

This paper discusses components of a flexible multiple-use forest management strategy within China's changing environment and market situation. The focus is set on sustainable management options and conversion plans for an exemplary pine plantation (*Pinus caribaea*) on Hainan Island and combines economical demands with social and ecosystem services.

Keywords: Biodiversity, China, multiple-use forest management, NTFP, plantation conversion

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Landscape History and Degradation in the Serra Dos Órgãos, Brazil

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The Serra dos Órgãos mountain range in the state of Rio de Janeiro retains Atlantic forest remnants of high importance for biodiversity conservation, water storage, soil erosion control, local climate stability, and leisure activities. Due to the proximity to Rio de Janeiro city, the human impact on forest remnants is notably high and not only limited to agriculture, but also to tourism, secondary residences, and road construction.

Against that background, the authors tried to find out how land use systems in different periods changed the land cover, affected deforestation rates, influenced landscape evolution, and finally led to the current landscape. Therefore, they analysed geomorphological processes and soil patterns and compared the findings with the local climate history as well as archaeological and historical data.

As a result, the Serra dos Órgãos can be divided into three main parts:

1. Foot hills and lower ranges have a long history of exploration: prehistoric and indigenous slash-and-burn agriculture, sugar cane plantations from the 16th century on, coffee cultivation in the 19th century and animal husbandry and tropical agriculture in the 20th century. These activities caused massive deforestation accompanied by soil erosion, hang slides and even local transitional climate changes. All forest fragments found here have a maximum age of 140 years.
2. The steep slopes are predominantly forested and under protection. Soil analyses and historical data show that the lower, accessible parts have been used for centuries. Relatively untouched forests with undisturbed soil profiles can only be found in the upper range.
3. The mountainous hinterland (800 - 1200 m.s.l.) is dominated by livestock farming and vegetable gardening. First European settlements date back to the late 18th century. Although anthropogenic influence is relatively young, forests are highly fragmented. However, soil degradation and erosion processes are considerably lower compared to the lowlands.

Apart from the spatial and temporal analysis, the work points out the interrelations between regional development, land use practices, deforestation and landscape degradation. The results are of considerable importance for further land use management.

Keywords: Atlantic forest, degradation, landscape history

Assessment and valuation of ecosystem services

Oral Presentations	321
ANOOP PARAMESWARAN PILLAI, S. SURYAPRAKASH: Use Values of an Estuarine Ecosystem: The Case of Ashtamudi Estuary in South India	321
HARTMUT GAESE, SABINE SCHLÜTER, RUI PEDROSO, JUAN CARLOS TORRICO: Farming Systems and the Protected Environment “Mata Atlântica” of Rio de Janeiro	322
JAN BARKMANN, EVA MARIA SCHNEIDER, STEFAN SCHWARZE: Sweet as Chocolate: Stabilisation of Ecosystem Services by Production of Cocoa in high-shade Agroforestry Systems in Central Sulawesi (Indonesia)	323
PABLO VILLALOBOS, CARLOS HUENCHULEO, RODRIGO SILVA: Economic Valuation of Environmental Services in <i>Nothofagus alessandri</i> (RUIL) Forests in the Region del Maule, 7th Region, Chile: An Application of the Choice Experiment Method	324
Posters	325
MONICA IDINOBA, JOHNSON NKEM, YACOUBA COULIBALY: Methodology for Vulnerability Assessment of Selected Economic Sectors of the Forest Ecosystem in West Africa	325
LIRON AMDUR, ELKE BERTKE: Transformation of Agri-Environmental Schemes in an International Context	326
XIAOBIN DONG, WANGSHENG GAO, YUANQUAN CHEN: Valuation of Fragile Agroecosystem Services in Loess Hilly-Gully Region - A Case Study of Ansai County in China	327
ZEMEDU LEMMA, KARIN HOLM-MÜLLER: Analysis of Economic Incentives for Nature Conservation: The Case of Amigna District, Ethiopia	328

**JAN BARKMANN, JIONG YAN, ANNE-KATHRIN ZSCHIEGNER:
Attitudinal and Cultural Influences on Preferences for Sustainable
Tourism Services in Southwestern China Forestry
Landscape**

329

Use Values of an Estuarine Ecosystem: The Case of Ashtamudi Estuary in South India

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Estuarine ecosystems are very unique with respect to biodiversity as well as the services provided to the community. Ashtamudi estuary in Kerala state is a RAMSAR site and designated as the “wetland of international importance”. It provides means of livelihood for the people surrounding it by way of fishing, coconut husk retting for coir production, and inland navigation services.

The estuary supports 92 identified fish species including prawns, crabs and other bivalves, of which 28 are of commercial importance. The clams from this estuary are being exported to countries like Japan. Retting of coconut husk, which is a pre-treatment for coir production, is another major economic activity and a source of livelihood for people. The value of this service alone is estimated at Rs 5.1 million per annum. The marketed use values of the estuary were assessed using the market value approach. It was found that fishery accounted for the major share amongst the total direct use values with Rs 66.8 million per annum. Inland navigation service is another major direct use value provided by the estuary which is also estimated using the market value approach. Recreation is a non-consumptive direct use value provided by the estuary which is estimated employing travel cost method.

The estuary also acts as the nursery for the marine prawn species. This is an important indirect use value that was estimated using replacement cost method. Recently this fragile ecosystem is facing serious threats from human as well as nonhuman involvements like over-fishing, pollution, sand mining, bank erosion, loss of mangroves, etc.

The study emphasised the economic as well as ecological importance of Ashtamudi estuary. The need of the hour to initiate necessary policy initiatives for appropriate management of the estuary to ensure its ecological sustainability as well as livelihood security of the stakeholders.

Keywords: Ashtamudi, wetland use values, bivalves, over-fishing

Farming Systems and the Protected Environment “Mata Atlântica” of Rio de Janeiro

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The Atlantic Rainforest of Brazil represents an example of a natural paradise under land-use pressure. Rich in biodiversity this “Mata Atlântica” is a favourite for natural scientists. The high share of endemic species is a strong argument for the conservation of natural forest. Extending along the most densely populated areas of Brazil, the forest regions are easy to be reached, offering beautiful landscapes to tourists. In areas difficult to access, as the characteristic rocky steep mountain range in the hinterland of Rio de Janeiro, large connected patches (fragments) of dense, mature Atlantic forest have been preserved.

In the less forbidding upland, the moderate climate and water abundance are favourable conditions for agricultural production, where highly productive horticulture systems have evolved. Many slopes have been turned into pasture land. Steep slopes and most of the mountain tops are still covered with forest vegetation, resulting in the typical mosaic landscape for the Mata Atlantica of Rio de Janeiro state.

Detailed studies on the interaction between agricultural land-use and forest fragments were conducted in a rural watershed of Corrego Sujo in the municipality of Teresópolis. The share of intensive horticulture land is only about three percent, extending at the bottoms of the valleys. Most of the horticulture farmers work on rented land in a sharecropper’s relationship with the landlord. Farm areas in horticulture are small, usually below one hectare. Still, those farms yield a decent family income for the majority of farmers. The risk of volatile prices is buffered by the variety of crops produced in a rotation with several crops of short production cycles.

For the rural population, near-nature forest fragments are an important component of the landscape. The function of forest in preserving water resources is widely recognised. Tourists admire the mosaic landscape, in which the shades of green of horticulture fields and pastures for cattle and horses are important components.

Keywords: Agricultural landscape, environmental perception, environmental services, farming systems, forest conservation

Sweet as Chocolate: Stabilisation of Ecosystem Services by Production of Cocoa in high-shade Agroforestry Systems in Central Sulawesi (Indonesia)

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Indonesia is a leading international cocoa producer. Within Indonesia, cacao agroforestry expansion is concentrated in the province Central Sulawesi including the region around Lore Lindu National Park (LLNP), where cacao area rose from zero (1979) to 17,984 ha (2001) and where new plots are partly established within LLNP. Additionally, an intensification syndrome with reduced and less diverse shading tree cover, and with increased fertiliser and pesticide application spreads in the region. These developments threaten remaining core ecosystems of the global Wallacea biodiversity 'hotspot'.

Based on data from 289 representative households in 12 villages of the LLNP region with 201 cacao plots, we economically compared extensive and medium intensified cacao agroforestry plots (average shading 70 %; 31 % of regional cacao agroforestry area) with more intensively managed plots (average shading 30 %; 69 % of area). Based on results from several coordinated ecological studies in the region, a shading reduction from 70 % to 40 % and below reduces total species richness of terrestrial herbs by ½, and nearly eliminates forest herbs. Also canopy ants and wasps substantially decline, and parasitism of herbivorous insects is likely to be reduced by ½. For extremely low and zero-shading situations, much more dramatic results have been documented previously.

On average, more extensive plots yielded 347 US\$ ha⁻¹yr⁻¹ gross margin, more intensive plots 546 US\$ ha⁻¹yr⁻¹. Second order stochastic dominance analysis reveals that - because of price and yield risks - more intensive agroforestry is not generally superior, however. Accounting for these risks, an additional gross margin of 160 US\$ ha⁻¹yr⁻¹ (0.39 US\$ kg⁻¹) would be sufficient to revert to high-shading agroforestry systems. Considering international price premiums for "fair trade" organic cocoa of up to >0.40 US\$ kg⁻¹, these results indicate a market-based potential for high-shading cocoa production that stabilises the provisioning of several ecosystem services and forest species habitat.

A certification scheme for "biodiversity-friendly" cocoa production has to guarantee production outside LLNP to avoid additional incentives for forest encroachment. In addition to external audits, effective monitoring and enforcement, a village-centred approach may be required as village headmen are regularly the decisive authority in local land access issues.

Keywords: Agroforestry, biodiversity, certification, cocoa, deforestation, economic incentives, ecosystem services, national park

Economic Valuation of Environmental Services in *Nothofagus alessandri* (RUIL) Forests in the Region del Maule, 7th Region, Chile: An Application of the Choice Experiment Method

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Nothofagus alessandri (Ruil) is considered to be the original species of the family Nothofagus. The Ruil forest, located in the central zone of Chile in the counties of Empedrado and Chanco, is an area that is considered to be a World Hotspot since it is the only place in the world that still maintains 450 hectares of the species, all of which justifies every effort made to value and conserve it. The main objective of this study was to estimate, in nearby communities, the marginal willingness to pay (WTP) for attributes associated with the environmental services generated by this forest resource. Through the application of the Choice Experiment method an economic valuation of the environmental services generated by the Ruil forest was carried out using a sample of 160 families from both communities. The existing correlation among the socio demographic variables and the choice of levels for each attribute was similarly analyzed. The three attributes valued during the survey were: the surface area of Ruil forest actually protected, the scenic beauty generated by this forest resource, and the implementation of protection and conservation programs for the flora and fauna living in the Ruil forests.

The attributes of greatest importance for the interviewees were the surface area of Ruil actually protected and the implementation of protection and conservation programs for the species living in the Ruil forests. For those attributes the interviewees are willing to pay US\$1.45 and US\$0.70 respectively per month, which represent a satisfactory initial amount for the preservation of the forest. The age, education and income variables showed a significant relationship with the choice of levels proposed for each attribute, which demonstrates the relevance of these variables in the valuation of environmental services. Finally, it is worth pointing out that the method used is adequate for valuing the willingness to pay (WTP) since it was well understood by the interviewees. The results generated by this study are a contribution to the design of Ruil forest resource conservation and protection strategies, especially in terms of the development of the required environmental services.

Keywords: Forest conservation, choice experiment method, willingness to pay

Methodology for Vulnerability Assessment of Selected Economic Sectors of the Forest Ecosystem in West Africa

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Forest ecosystems provide both primary and secondary goods and services to a number of economic sectors in developing economies where the dependence on natural resources is still soaring. Current and projected climate shocks and stresses are expected to render such economies highly vulnerable or have a devastating impact on the economic sectors and the livelihood of millions of people that depend on the forest sectors.

Generally in West Africa, the forest ecosystem provide high valued goods and services which are currently threatened. Several millions of people derived livelihood support from forest and its related sectors particularly during years of poor agricultural productions. A significant reduction of the availability of these goods and services coupled with high variability in their productivity is considered by local community as evidence of climate change in the region. However, the level of vulnerability of these sectors of the forest ecosystem due to climate change impact and specific effects this will have on the community who depends on them is yet to be determined scientifically. The need for vulnerability evaluation and potential risks on economic sectors, resulting from climate change impact on the forest ecosystem, taking into account regional participation in the development of methods and their application for sectoral evaluation is a necessary condition for planning right adaptation in the region. Sectoral vulnerability assessment of forest ecosystems is an indispensable aspect to successful development assistance and sustainable development policy formulations for achieving the United Nation's Millennium Development Goals in West Africa. This information is necessary for the formulation of meaningful forest ecosystem based adaptation measures and policies. Hence, in this paper, the vulnerability of the forest ecosystem is viewed from a sectoral approach, by linking sectoral vulnerability of economic sectors to the opportunities forest ecosystem provides for national development or the absence of it. On one hand, it proposes a step by step methodological framework for vulnerability assessment of sectors jointly identified by stakeholders as important for its national development and on the other, shows the danger of treating the forest in isolation or over look the important sectors that feeds on forest ecosystems.

Keywords: Economic sectors, forest ecosystem, vulnerability

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Transformation of Agri-Environmental Schemes in an International Context

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In order to guide the impact of agriculture on the environment, many countries have established diverse economic, regulatory and advisory measures. The EU's "agri-environmental schemes", in which farmers are paid to practice environmental cultivation, may set a benchmark for developing countries as well. The challenges associated with the adoption of European agri-environmental policies in developing countries will be explored here, using Israel as a case study. Israel, with stronger economy than many developing countries, nevertheless shares some significant characteristics with them, such as a high rate of population growth, the emergence of "mega-cities", and limited resources for agri-environmental schemes. Drawing from ongoing efforts to develop agri-environmental schemes in Israel, it is concluded that several aspects of European schemes should be modified when implemented in other geographic contexts: **(1)** Matching the characteristics of the local ecosystem - North-European agri-environmental schemes emphasise production extensification; in Israel, as in many other Mediterranean countries, biodiversity is dependant on agricultural cultivation, and the pressing problem that agri-environmental schemes should tackle is the abandonment of fields. **(2)** Land use patterns - European agro-environmental schemes are usually practised in rural areas. In Israel, as in many developing countries, agriculture and biodiversity conservation are practised more and more in the urban context, which places environmental considerations in an inferior position to urban land-use demands. However, city dwellers may donate financial support for agri-environmental programs. **(3)** Institutional framework - European agro-environmental schemes are grounded in a long tradition of agricultural subsidies. In Israel, as in many other countries, there are no income-payments for farmers; however, other types of institutional support (extension services, investment support) may be mobilised for environmental purposes. **(4)** Farmers / conservationists relations - The current cooperation between farmers and conservationists in Europe is a result of a long reciprocal discourse between the interests groups. In Israel, where public discussion on agro-environmental issues is more recent, farmers and conservationists' participatory frameworks may radicalize conflicts rather than mitigate them, and therefore it is advisable to consider other forms of participation. We outline possible solutions to the presented challenges, which may be useful in other countries around the world.

Keywords: Agro-environmental schemes, biodiversity, policy adaptation, policy transfer

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Valuation of Fragile Agroecosystem Services in Loess Hilly-Gully Region - A Case Study of Ansai County in China

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Much research has been done since the concept of ecosystem service was put forward. However, this previous research focused mostly large (global or national) scale and has hardly cared about the fragile agroecosystems disturbed by human being, such as that on the Loess Plateau. On this plateau an aggravating ecological environment exists because of severe soil erosion and harsh natural conditions. Using different methods such as market value, substitution engineering, shadow price and opportunity cost, the value of agriculture ecosystem services including conserving soil (Es) and water (Ew), fixing CO₂ and releasing O₂ (Ea), maintaining nutriment circling (En) and decontaminating environment (Ee) in Ansai county in Loess hilly-gully region are calculated in this article.

The results show that the gross value of ecosystem service is 31698.70 million Yuan which is 170 times of production value (Ep) implying that even the fragile ecosystem plays an important service function though it has been disregarded for a long time. In Ansai county, agroecosystem provides great ecology services for economic productivity. The various services value respectively is En 28481.42 million Yuan (RMB) (90 percent), Ew 1391.36 million Yuan (RMB) (4.4 percent), Ea 1325.11 million Yuan (RMB) (4.2 percent), Vp 185.06 million Yuan (RMB) (0.6 percent), Es 258.25 million Yuan (RMB) (0.8 percent), Ee 57.51 million Yuan (RMB) (0.2 percent). Moreover, the results also show that there is an imbalance between ecological productivity and economic productivity in this area, which is a general problem all over the Loess Plateau. The prioritised approach for restoring the ecological environment is to extend the areas of grassland and forest in order to improve conservation of soil and water.

Keywords: Agroecosystem service, loess plateau, valuation

Analysis of Economic Incentives for Nature Conservation: The Case of Amigna District, Ethiopia

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The tropical environment provides sufficient radiation for maximal biomass production but drought, low soil fertility and socio-economic problems are dominating limiting factors for agricultural production. Ethiopia is one of the poorest developing countries located in the tropics. Agriculture is the mainstay for about 85 % of Ethiopian population, who repeatedly faces famine due to natural resources degradation.

A study was made at Amigna district, located in the southeastern of Ethiopian central highlands for three months from April to June 2003. Participatory Rapid Appraisal (PRA) method was used to collect information. Among PRA techniques, secondary data review, direct observation, semi-structured interview and focus group discussion were applied. Different types of semi-structured PRA tools were used; such as individual interview, Group interview, and key informant interview.

Information on the interaction of natural systems and different livelihood circumstances in Amigna district was gathered. Major direct causes of natural resources degradation were identified that contributes to over-exploitation of natural resources, destructive harvesting systems and land use practices, and conversion of natural habitats. The underlying causes for the natural resources degradation were explained in relation to failures in livelihood circumstances, market failures, institutional and policy failures. Needs and niches for economic incentive measures were also briefly indicated as, when the community needs incentives, for which particular group of the community and at what circumstances do incentive measures required?. Opportunities for alternative sources of livelihoods as an indirect incentives and strengthening the efficiency of natural resource utilisation for some of existing income sources as a direct incentive measures were indicated. Appropriate economic incentives for natural resource conservation at Amigna district were suggested based on the analysis of information obtained in this preliminary study. These economic incentive measures were suggested under categories of property rights, market, and livelihood, fiscal and financial measures. Finally, awareness creation and international cooperation were suggested as supportive measures for practicability of the suggested economic instruments for the conservation of natural resources at Amigna district of Ethiopia.

Keywords: Natural resource degradation, PRA tools

Attitudinal and Cultural Influences on Preferences for Sustainable Tourism Services in Southwestern China Forestry Landscape

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The booming tourism industry in China causes increased resource consumption, and threatens ecologically sensitive areas. These issues are particularly crucial in southwestern China, which harbours one of 25 global biodiversity hotspots, and is a popular destination for domestic Chinese tourists. In the study reported here, we assess influences on Chinese domestic tourist destination choice relevant to the sustainable tourism development in southwestern China in a two step process. First, the influence of attitudes on sustainable tourism services is analysed. In the second step, attitudinal influences are supplemented by an analysis of indirect, cultural influences expressed by tourist images of nature. Technically, we utilise a choice experiment to assess the influence of destination attributes - including availability of sustainable tourism services -, of attitudes and of images of nature on destination choice. Data was collected from 213 middle class respondents in Beijing and Chengdu. Factor analysis singled out two 'positive' attitudinal dimensions (in favour of sustainability, concern for losing opportunities) and one 'negative' attitudinal dimension (sceptical attitude on sustainable tourism). Only the sceptical attitude significantly influence the destination choice. The sceptical attitude counterbalanced the positive willingness-to-pay for sustainable tourism services from 4480RMB to 450RMB. In the second step, only the robustness by divine designer and the non-spirituality image of nature dimensions display substantial impacts on preference variations. The more spiritual the image of nature of a Chinese middle class tourist, the more s/he prefers - and is willing to pay for - trips featuring more natural attractions and more sustainable tourism services. In sum, our study suggests that there are attitudinal barriers that hinder a substantial share of Chinese middle class tourists to accept sustainable tourism services. The generally positive attitude towards sustainable tourism stated in attitudinal surveys does currently not translate easily into sustainable consumption and production opportunities in the tourism industry.

Keywords: Sustainable tourism, destination choice, image of nature

Institutions and management of ecosystem services

Oral Presentations	333
ASTRID ZABEL: New Policy Approaches to Resolve Carnivore-Livestock Conflicts in the Tropics	333
JÖRG EGGERS, EVY METTEPENNINGEN, VOLKER BECKMANN: Local Action Groups and Auctions: Assessing the Efficiency of Institutional Innovations for the Design and Implementation of Agri-Environmental Measures in the EU — Results from an Expert Survey	334
HORST WEYERHAEUSER, HE JUN: Assessing Pro-Poor Mechanisms of Payment for Environment Services from Forests: Lessons Learned from Government-Led Programs in Southwest China	335
CHRISTINA SEEBERG-ELVERFELDT, STEFAN SCHWARZE, MANFRED ZELLER: Payments for Carbon Sequestration Services - A Solution to Stop the Deforestation of the Lore Lindu National Park in Indonesia?	336
Posters	337
TEKLU TESFAYE: Resource and Community Attributes Influencing the Conservation and Use of Coffee Forests in Southwest Ethiopia	337
GHASSEM HABIBI BIBALANI, LILA JOUDI, SHAHRIAR SOBHE ZAHEDI: Soil Stabilizing Characteristics of Rangelands Vegetation in Northwest Iran (Misho Rangelands Protected Location of Shabestar)	338
DEEPESH PUTHIYAPURAYIL CHANGAT, MANJUNATHA ARAHALLI VENKATARONAPPA: Institutions of Sustainability: An Analysis of the Mangrove Ecosystem of Kerala, India	339
TANTY S. THAMRIN: Community Based Natural Resource Conflict Management: A Case Study from Lore Lindu National Park, Indonesia	340

MARIJE D. BIJ DE VAATE, JULIA NDUNGU-SKILTON, TOBY HODGKIN: The Platform for Agrobiodiversity Research	341
JOHANNES RUPP: Integration of Smallholder Farmers in International CO₂-Markets by Applying Agroforestry Practices in Western Kenya	342
KLAUS GLENK, JAN BARKMANN, SUSANNE BÖGEHOLZ: Preferences for Rattan Around Lore Lindu National Park, Central Sulawesi (Indonesia) as an Ecosystem Product: A Socio-Ecological Open Access Dilemma at Work	343

New Policy Approaches to Resolve Carnivore-Livestock Conflicts in the Tropics

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Conservation of large carnivores is an important component of the global societies' goal to conserve biodiversity. However, carnivore-livestock conflicts often impose serious hardship on poor livestock owners in marginal areas. Around the world, ex-post compensation schemes have been installed to compensate livestock owners for losses due to predation by endangered carnivores. Although well intended, these ex-post compensation schemes often do not provide explicit incentives for conservation. This paper reviews case studies on carnivore-livestock conflicts in the tropics that focus on compensation schemes. Typical problems that recurrently are mentioned in connection to ex-post compensation such as moral hazard, high transaction costs, long time lags, and problems of trust and transparency are discussed.

A new performance payment approach is proposed as alternative to ex-post compensation. Under the proposed scheme, livestock owners are rewarded based on the number of carnivore offspring that are borne on their livestock's grazing area. These payments are made independent of actual livestock losses. Performance payments belong to the larger group of payments for environmental services. Currently, this approach is only being tested at a large scale in Sweden.

Since allocating the payments to individuals may prove to be intricate in a carnivore conservation context, making payments to groups of livestock owners is proposed. Devolving the right to decide on the internal use and distribution of payments to groups, e.g. communities, may be advantageous but is also likely to give rise to new challenges. The hypothesis set up in this paper is that a performance payment scheme, if well adjusted to local circumstances in the tropics, may be able to align conservation with poverty alleviation. While certainly not a panacea, performance payments may be an interesting alternative use of funds that are currently spent on ex-post compensation.

Keywords: Carnivore conservation, livestock, performance payments, poverty alleviation

Local Action Groups and Auctions: Assessing the Efficiency of Institutional Innovations for the Design and Implementation of Agri-Environmental Measures in the EU — Results from an Expert Survey

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In this article, the authors focus on two important innovations for agri-environmental measures in the new council regulation: The implementation of local actions groups and a call for tenders. The article describes how relevant actors in the design and implementation of agri-environmental measures assess these innovations. The results are based on 276 interviews, carried out in 2006 in nine EU Member States.

Generally, actors assume that measures designed in local action groups are not necessarily more economically efficient than current measures, but they do have potential to result in a higher ecological effectiveness and in a greater acceptance. In evaluating the potential of auctions, or the call for tender approach, respondents were comparatively critical. However, the assessment of local action groups and auctions depends to a large degree on the group a respondent belongs to. Actors from the environmental administration, environmental associations and researchers see a high potential in local action groups and are indifferent to critical concerning the implementation of auctions. Conversely, actors from the agricultural administration and farmer associations tend to be indifferent or disagree, that local action groups increase economic efficiency, environmental effectiveness and acceptance and assess the potential of auctions as negative. Local action groups and auctions were also better evaluated by the lower administrative levels, which is probably due to the expectation of a higher influence when these institutional innovations would be applied. Finally, countries in the research that already have more experience with bottom-up approaches, evaluate the innovations more positively.

Nevertheless, for these bottom-up approaches, especially the budget is seen as an obstacle, but also the risk averse behaviour of the responsible civil servants, the unsuitable general administrative structure and the higher control costs pose problems. For most countries it can be concluded that as long as agricultural administration and farmers associations are by far the most influencing groups on the design process of agri-environmental measures, bottom up approaches will remain an exception.

Keywords: Agri-environmental policy, decentralisation, local action groups

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Assessing Pro-Poor Mechanisms of Payment for Environment Services from Forests: Lessons Learned from Government-Led Programs in Southwest China

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

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

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

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

Keywords: China, Ecological Forest Compensation Program (EFCP), Payment for Environmental Services (PES), Sloping Land Conversion Program (SLCP), Watershed Protection

Payments for Carbon Sequestration Services - A Solution to Stop the Deforestation of the Lore Lindu National Park in Indonesia?

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Indonesia is one of the countries with the highest annual net forest loss, and during the last five years two percent of its remaining forest area were lost every year through deforestation, selective logging or human intervention. Deforestation in turn plays an important role in the global warming process, accounting for up to 20 percent of the global greenhouse gas emissions. Frequently smallholders' traditional land-use and forestry activities are partly responsible for deforestation. Therefore, when emission reductions are targeted, small farmers can make a positive contribution through the adoption of sustainable land-use practices.

The present research assesses whether payments for carbon sequestration activities can provide an incentive for forest conservation in the Lore Lindu National Park in Central Sulawesi, Indonesia. The encroachment on the forest margin of the Park through agricultural activities and especially cocoa production is occurring at an alarming rate. Hence, different forest management options and their potential carbon sequestration payments are appraised in the study. The net present value of the service payment was obtained, accounting for the carbon content of the agro-forestry systems, as well as the potential payments when avoiding further deforestation and the "saved" carbon. Consequently, the impact of the compensation payments on household incomes was assessed in diverse scenarios.

A household survey in the surroundings of the park was carried out to collect the data on the existing agricultural production systems. To analyse the households' behaviour and their resource allocation, a linear programming model was used. Four household categories were analysed, based on the dominant agroforestry type within their agricultural production system. The baseline situation for the four categories was generated and various scenarios were run for payment options. A sensitivity analysis took several carbon prices into account.

The research helps to develop instruments for the provision of environmental services, specifically carbon sequestration. It shows whether the current carbon prices are sufficient to compensate the opportunity costs of the farmers when they change their land-use practices, assist the conservation of the remaining forest and impede further resource degradation.

Keywords: Agroforestry, carbon sequestration, economic incentives, linear programming, payments for environmental services

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Resource and Community Attributes Influencing the Conservation and Use of Coffee Forests in Southwest Ethiopia

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Community and resource systems attributes are important in influencing the conservation and use of natural resources. Resource system attributes define the type of resource and they also dictate the type of property right systems that best ensure their sustainable management. Community attributes on the other hand shape decision making behaviour and their resource utilisation strategies. This study was conducted in the southwest part of Ethiopia with the main objective of understanding community and resource attributes that influence the conservation and use of coffee forests. Data were collected using qualitative methods viz. key informant interview, focus group discussion, and participant observation; and quantitative methods viz. formal household surveys. The study revealed that coffee forests exhibited such attributes as low excludability, high subtractability, high rate of mobility and low storage in the system, which all are the attributes of common pool resources. However, they have remained public properties quite for long and that did subject them to degradation. In so far as there is an identifiable outcome to the public ownership of the coffee forest (degradation), it lies in a preferential shift away from the standardised central state provision toward recognition of, and sympathy for, diversity, experimentation and multi/actor arrangement. Communities differed in such attributes as resource endowment, ethnicity, education, and religion; and in the perception of their own actions on the physical condition of coffee forests. On the other hand, they shared similarities in such attributes as livelihood strategies, dependence on the coffee forests, and in the autonomy to design institutions and past experience in self-organisation. When communities who share some key attributes also differ in the strength of some other key variables, aggregate resource management behaviour is often characterised by frequently dependent behaviour with strong threshold effects. The variations in some and similarities in others shape their resource utilisation strategies. The design and implementation of any institutional measure aimed at improving the management of coffee forests should therefore take these differences and similarities in attributes into account.

Keywords: Coffee forests, communities, resource conservation

Soil Stabilizing Characteristics of Rangelands Vegetation in Northwest Iran (Misho Rangelands Protected Location of Shabestar)

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The composition of rangelands vegetation influences how well a rangelands area functions and hence has an important effect on the state of a slope. In northwest Iran, much rangelands vegetation was cleared for agricultural land use consequently ecosystem services provided by rangelands vegetation have been lost or seriously changed. The ecosystem services provided by rangelands vegetation are vital, and vary from stabilising slopes and filtering runoff, through shading and protection of animal habitats, to enhancing aesthetics and controlling downstream flooding. Of these, slope stabilisation is often regarded as being of high importance because, without it, many of the other functions may be limited by erosion and its consequences, e.g., undesirable changes in rangelands slope morphology, and excessive in stream sedimentation. The stabilising role of rangeland vegetation depends on increase the shear strength of slopes soils, protect surface soil, take water from the soil (via transpiration and evaporation), increase filtration of soil, support the toe of slope (buttressing), protecting it from shear failure. These functions can be affected by the rangelands slope scale and slope steepness. Eight plants of each species were measured for height, canopy spread, root collar diameter and maximum root depth, and lateral root spread. To obtain canopy spread the maximum diameter of the foliage was measured in both an E—W and N—S direction and averaged. Roots of plants stable soils on slope and provide resistance against the forces that improve slope instability. In the northwest of Iran (East Azarbayjan state), rangelands were changed to agricultural land use; this vegetation is unsuitable vegetation on a slope to stable them. Restoration of rangelands vegetation effects, largely to improve slope health, is focussed on replacing agricultural plants with rangelands species, but little is known about their slope stabilising characteristics. We studied 4 rangelands plant species to determine these characteristics. Data available for 2 and 3 year old shrub plants indicate that Gavan (*Astragalus raddei*) has high root spread and rooting depth. Data for older plants of this species will be used to improve landslide threshold models for vegetated slopes.

Keywords: *Astragalus*, Iran, landslide, rangelands

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Institutions of Sustainability: An Analysis of the Mangrove Ecosystem of Kerala, India

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Mangroves are salt tolerant plants in saline coastal tropical and subtropical regions of the world. They are rich ecosystems, provide various natural products and perform various environmental functions. In spite of all these benefits, mangrove ecosystems are being destroyed all over the world especially in Asian countries. The major cause of destruction was attributed to intensive shrimp farming and aquaculture practices being taken up in coastal areas. Experiences have proved that the presence of mangrove ecosystems on coastline save lives and property during natural hazards such as cyclones, storm surges and erosion (MSSRF report). This paper tried to analyse mangrove ecosystem from an institutional dimension using Institutions of Sustainability (IoS) frame work which was developed by Hagedorn et al emphasising on different actors, transactions, property rights, governance structures etc. related to mangrove ecosystem. The results indicate that, untapped potential of mangrove ecosystem is not fully understood by the local community and are trying to exploit maximum in spite of visible governance structure. Still there exist loop holes to exploit this ecosystem such as converting existing system first to rice field and in later period covert to real estate areas. People are thinking about the present benefit than the future one since the legal property right rests with private ownership. Hence, property rights have to be viewed in following dimensions: **i)** Over exploitation and pollution of the Mangrove ecosystem **ii)** private land use pattern property right **iii)** property rights in forest or special ecosystem preservation areas in order to protect this precious species from exploitation. The IoS frame work proved to be very useful for analysing the institutions existing in the mangrove ecosystem of Kerala, results can be used to identify the different actors and transactions and can think how they can be efficiently and effectively used in future to make mangrove ecosystem more sustainable by framing suitable environmental policies. This paper in detail discuss about the mangrove ecosystem and how the Institutions of Sustainability frame work can be used to explain it.

Keywords: IoS frame work, Kerala-India , mangrove ecosystem, sustainability

Community Based Natural Resource Conflict Management: A Case Study from Lore Lindu National Park, Indonesia

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Addressing and managing the conflict over resources can be very useful for the communities in making their needs and rights clear and helping to solve injustices or inequities in resource distribution. The establishment of the park by the Central Government involved a lengthy consultation process, but with limited participation of local communities. Different interest and perceptions of the various stakeholders are the roots of the conflicts that occur in the park. The study present a qualitative analysis, focus in the stakeholder reaction regarding the existed Collaborative Management and the experiences dealing with conflict management in the Lore Lindu areas. The study describes how communities managed and solved the conflict over natural resources as an effort to sustain their livelihood. Natural resources conflict in LLNP analysed in term of policy, regulation, and management framework. The study used Stakeholder Analysis for Conflict Management as starting point to identify the stakeholder to be interviewed, observed, and participated on the FGD. Conflict Management in the park analysed in regard with participation, negotiation, compromise, accommodating, consensus, and agreement in resolve the dispute. The results of the study show that the natural resource conflict can be solve through negotiation, compromise, accommodating, consensus, and agreements for temporary period with weak agreement. Due to the voluntary character, the conflict resolution process in community level need to consider both the community sustainability livelihood and the preserve area conservation functions. Collaborative Management in term of (indigenous) community conservation agreement might be serve as a bridge to facilitate the natural resources conflict management with several pre-request; the community conservation agreement is respected and implemented by the parties and parties are commit to monitor and evaluate the agreements continuously. In conclusion, the study showed that natural resource conflict management in conservation area through negotiation, compromise, accommodating, consensus, and agreement is not suitable to be use on criminal cases (such as illegal logging, forest area destructions, and conservation area sale case) and to be use as permanent solution method.

Keywords: Community based management, conflict management, natural resource.

The Platform for Agrobiodiversity Research

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The Platform for Agrobiodiversity Research, established in 2006, provides a framework for collaboration and cooperation among those working on different research areas of agrobiodiversity who share a common concern to maximise its contribution to human well-being.

Agricultural production systems are becoming increasingly simplified and vulnerable with loss of crop and livestock varieties, trees, soil organisms, pollinators, species that help control pests and many other useful wild species found in and near agricultural production systems. The problem is most acute in developing countries, where farmers agrobiodiversity can play a key role in enabling farmers to cope with such problems as market shifts, climate change or new disease threats.

The overall goal of the Platform is to enhance sustainable management and use of agrobiodiversity for human needs by improving knowledge of all its different aspects. It does this through promoting the sharing of information, identifying the contribution of agrobiodiversity to major global issues, as well as through supporting research development.

To achieve its goals the Platform encourages and facilitates sharing of experiences through meetings and e-discussions, supports communication among scientists, policy makers and practitioners, and provides information that helps link organisations and researchers around key research issues. It also works on bridging gaps between North and South, conservationists and agriculturalists and those working on different components of agro-ecosystems.

The work of the Platform is defined by significant global agendas on agricultural research for development, such as the Millennium Development Goals, FAO's Commission on Genetic Resources for Food and Agriculture and the 2010 Biodiversity Target of the CBD.

The Platform for Agrobiodiversity Research is hosted by Bioversity International, and operates with a small Secretariat based in Rome, Italy, and Nairobi, Kenya.

Keywords: Agrobiodiversity, facilitation, global network, research

Integration of Smallholder Farmers in International CO₂-Markets by Applying Agroforestry Practices in Western Kenya

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Rural areas in Western Kenya are beside the high population density in particular characterised by badly degraded soil and vegetation patterns, caused by conventional cropping practices, overgrazing as well as an increased number of unpredictable rainfalls. As a result these conditions lead to extreme poverty among rural households such as smallholder farmers. In order to improve rural livelihoods as well as enhance biodiversity and mitigate climate change, agroforestry practices are on the way to find further application in the region around Lake Victoria. As part of a master research, carried out by the Humboldt-University, Berlin, in cooperation with the World Agroforestry Centre (ICRAF), institutional settings of smallholder farmers will be analysed in order to meet international CO₂-markets like the Clean-Development-Mechanism (CDM) as an instrument of the Kyoto-Protocol and Voluntary Markets as the Chicago Climate Stock Exchange. Targeting international CO₂-markets by applying agroforestry practices in form of diversified land use systems are currently still neglected.

The emphasis of this research - carried out in spring/ summer 2007 - is based on two catchment areas in Western Kenya, the Nyando and Yala river basins. These two areas have different organisational and cultural structures among smallholder farmers, which include individual and common activities as well as participation of women and youth. In order to target the challenges demanded by requirements of international CO₂-markets, driving and limiting factors affecting the integration of smallholder farmers will be elaborated by focusing on local-level institutions. Group interviews as well as in-depth interviews with key informants will target the following points: **i)** mobilisation and empowerment of smallholder farmers by prioritising tree planting activities, **ii)** general perception of smallholders towards carbon markets, including the role of by-laws, **iii)** as well as distribution of project benefits in terms of individual and common expectations.

Having in mind, the present difficult status of projects integrating smallholder farmers in international CO₂-markets, the generated outputs of this research will make it easier to discuss future issues on project design and implementation. This is in particular of interest in order to achieve one of the basic objectives of international CO₂-markets, sustainable development of developing countries.

Keywords: Agroforestry, international CO₂-markets, smallholders, sustain and improved livelihood, western Kenya

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Preferences for Rattan Around Lore Lindu National Park, Central Sulawesi (Indonesia) as an Ecosystem Product: A Socio-Ecological Open Access Dilemma at Work

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After the demise of the resource elsewhere, Central Sulawesi is a main source of rattan worldwide (*Calamus* spp.). Encounter distance to harvesting locations increased already from 4.4 km (1990) to 14.5 km (2001) around Lore Lindu National Park (LLNP). Although a concession system is established and extraction from LLNP forbidden, observations suggest that rattan extraction follows an open access pattern. We use data from a study with 301 representatively sampled households from 12 villages in the LLNP region to test if the local (as well as growing international) scarcity of rattan is reflected in economic preferences for this important non-timber forest product.

Preference data were generated by a choice experiment including a rattan attribute operationalized by the encounter distance of the nearest extracting location measured from the forest margin (5, 10, 15, 20 km). 289 valid interviews were obtained. 12.8% of respondents were rattan collectors, most belonging to the poorest third of the population. Nested logit analysis reveals a mean valuation of 5,600 IDR km⁻¹ change in rattan encounter distance per rattan collecting household per year. One km encounter distance is associated with a time saving of ~0.4 hours ($p < 0.01$; OLS regression; $n = 37$). With 18 rattan collecting campaigns per rattan collecting household per year and income from unskilled wage labour of about 10,000 IDR per 10 h (i.e., an absolute poverty income of less than 1USD day⁻¹), 1 km converts into 7.2 h saved time, equating 7,200 IDR per rattan collecting household per yr.

Accounting for the fact that rattan extraction is a highly unpleasant 'drudge'-type work with lowest social prestige, our results indicate that rattan collectors value changes in the economic status of the local rattan resource roughly at the time saving associated with the changes. We interpret this result as indicating the existence of a socio-ecological dilemma typical for open access situations in which the poorest population segment of different localities competes for the resource without any regard for its increasing scarcity. Locally perceived values are the result of a 'run to the bottom' as they approach absolute physical subsistence requirements for the reproduction of the labour needed for its extraction.

Keywords: Absolute poverty, ecosystem services, open access, rattan extraction, socio-ecological dilemma

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Trade-off between conservation and development goals

Invited Paper	346
SVEN WUNDER: Payments for Environmental Services: Bridging the Trade-Offs between Tropical Conservation and Development	346
Oral Presentations	347
DANIEL CALLO-CONCHA, MANFRED DENICH, PAUL L. G. VLEK: An Approach to Environmental Services by Land Use Systems Assessment; Functional Biodiversity in Tropical Agroforestry Systems (The Case of Tomé-Açu Community, Northern Brazil)	347
SONJA VILEI, STEPHAN DABBERT: Locally Derived Indicators for Evaluating Sustainability of Farming Systems	348

Payments for Environmental Services: Bridging the Trade-Offs between Tropical Conservation and Development

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Over the past couple of decades, it has with respect to tropical forest conservation become increasingly clear that the so-called ‘win-win’ scenarios are rare exceptions: more often than not interventions are faced with hard trade-offs between environmental goals and immediate welfare improvements. Payments for Environmental Services (PES) are designed explicitly to address such trade-offs through compensations. PES refer to voluntary, conditional agreements between at least one service buyer and one seller over a well-defined environmental service, or land-use assumed to produce that service. Designed as targeted incentives, PES have the potential to become a highly cost-efficient environmental management tool. At the same time, PES could attract new sources of conservation financing, in particular from the private sector. However, while many economists strongly believe in the potential of PES, many professionals from other disciplines remain overwhelmingly skeptical. This presentation sketches and evaluates opposed viewpoints around the following five PES dimensions: definition of the environmental service, land and resource tenure, incentive efficiency, development implications, and equity concerns. The discussion is enriched by observations from real-world PES examples in tropical countries, drawing on comparative work by the Center for International Forestry Research (CIFOR). The results can help us understand what we can realistically expect from PES, between the extremes of magic potion and neoliberal venom, and under which preconditions their application may be useful.

Keywords: Payments for environmental services, economic incentives, development, compensation, land use change

An Approach to Environmental Services by Land Use Systems Assessment; Functional Biodiversity in Tropical Agroforestry Systems (The Case of Tomé-Açú Community, Northern Brazil)

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Currently, the environmental services concept and its assessment seems the most appropriate approach to estimate, evaluate, conserve and in general make environmental use sustainable. The most well known environmental services are water purification and carbon sequestration. However, there are knowledge gaps.

In the case of biodiversity, for example, evaluation has mostly been based on quantitative or qualitative studies of individuals and functional groups.

We suggest functional biodiversity as an indicator of the sustainability of land-use systems, as it is closely related to the variability, resilience and dynamics of ecosystems. The application of the Criteria & Indicators (C&I) approach addresses this intention, operationalizing the functions involved in three main clusters: productive, ecological and operational through the definition of a sufficient number of indicators to represent the most relevant interactions. Such indicators are mainly process based and underline the impact of human intervention on ecosystems.

In this framework, the objective of this research is to assess the factors influencing the biophysical processes that determine the capabilities of agroforestry systems to maintain functional biodiversity, underlining the importance of the management factor to make them more productive and sustainable. The data collecting methods include: ecological field studies, interviews and secondary sources review; the units of analysis are agroforestry plots in small farmer properties; data processing is supported by multi-criteria protocols: work-shops at different levels of target groups and specialised software (CIMAT2.0); and statistical multivariate analysis: the protocols of cluster analysis and factor analysis, assisted by SPSS 11.5.

The results attend to the development of an assessment protocol of functional biodiversity in agroforestry systems and an interactive optimisation —support decision-model for farmers.

Keywords: Agroforestry systems, environmental services, functional biodiversity, multivariate analysis

Locally Derived Indicators for Evaluating Sustainability of Farming Systems

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A lot of research has focused on developing indicators for measuring sustainability of farming-systems. But only recently has it been widely acknowledged that there is no “one size fits all” set of indicators, but that sustainability indicators should be adapted to local conditions and therefore involve the opinions of the different stakeholders concerned.

This study presents first results of an ongoing study project on the island of Leyte, Philippines. Three study sites were chosen for identification of sustainability indicators and for a later comparison of local farming systems. Stakeholders identified included farmers, being either involved in a development project or not, as well as government officials, University researchers and NGO workers. Eight focus group discussions were carried out with the farmers, while the other nine stakeholders were interviewed individually. Indicators of successful/sustainable farming practices were identified and organised using the Sustainable Rural Livelihoods Framework, which is based on five capital assets: financial, physical, natural, human and social. Indicators were then ranked by participants.

The farmers perceived security of tenure to be of utmost importance for a sustainable farming system followed by the access to credit to buy farm implements, while most other stakeholders ranked (high) income as priority, and assumed that farmers would answer the same. Overall, the farmers ranked mainly natural indicators (soil, climate) high, while other stakeholders had the indicators distributed more evenly among financial, human, social and natural indicators, being dominated by financial indicators.

Certainly this qualitative way of research has its methodological problems, starting with the need for translators and a different cultural understanding of terms, such as sustainability. But it is concluded that the SRL Framework is well suited for exploring local views on sustainability of livelihoods and farming systems.

Keywords: Local indicators, Philippines, sustainability indicators, sustainable rural livelihoods

Current advances in analysis and modelling techniques

a)	Current advances in analysis techniques	351
b)	New applications of modelling	369
c)	Spatial explicit modelling of land use change	383
d)	Soil fertility and management of organic matter	397
e)	Organic agriculture	415

Current advances in analysis techniques

Oral Presentations	353
MELVIN LIPPE, NGUYEN VAN DUNG, TRAN DUC VIEN, T.T. KIEN, THOMAS HILGER, GEORG CADISCH: WaNuLCAS Modelling of Improved Swidden Agriculture Systems by Indigenous Fallow Management with <i>Melia azedarach</i> in the Uplands of Ban Tat, Northern Viet Nam	353
FOLKARD ASCH: Scale Specific Adaptations of Drought Responsive Systems	354
MARCO OTTO, JAN RICHTERS: Analysis of Vegetation Changes in High Andean Wetlands Using Remote Sensing as a Contribution to Environmental Planning in Southern Peru	355
PAVEL PROPASTIN, MARTIN KAPPAS, STEFAN ERASMI: Estimation of Carbon Balance in Drylands of Kazakhstan by Integrating Remote Sensing and Field Data with an Ecosystem Model	356
Posters	357
EIKE LUEDELING, JENS GEBAUER, JOERG SCHUMACHER, KAMAL EL-SIDDIG, ANDREAS BUERKERT: Spatial Expansion of Urban Agriculture in Khartoum, Sudan	357
LJAJEM ZERAY, JACKSON ROEHRIG, DILNESAW ALAMIREW CHEKOL: Calibration and Validation of SWAT Hydrological Model for Meki Watershed, Ethiopia	358
JAN-PETER MUND, SEYHA SOK: Mapping Land Cover Changes and Agricultural Transformation Processes in Cambodian Upland Regions with its Spatial Impact on Smallholder Food Production	359
KHALID SIDDIG, SIEGFRIED BAUER: Lessons Learnt from Three Social Accounting Matrices	360
HASSAN MAHMOUD WIFAG, JACKSON ROEHRIG, ETTAYEB GANAWA: Assessing the Potential of Floodwater Harvesting in Seleit Area Wadis, Sudan - Using Remote Sensing and GIS	361

TARIG ELSHEIKH MAHMOUD, MANAL AWAD KHEIRY: Contribution of Gum Arabic Production to Household Food Security in North Kordofan, Sudan	362
RUI PEDROSO, HARTMUT GAESE, SABINE SCHLÜTER: Exploring Land Use Systems in Rural Settlements, Upper Egypt: Combining Biophysical Possibilities and Socioeconomic Goals	363
SALWA ALMOHAMED, WERNER DOPPLER: Performance Measurement of Farming Systems in Resource Management Using Non-Parametric Model – A Case from North Syria	364
NAZAIRE S. I. HOUSSOU, MANFRED ZELLER, GABRIELA AL- CARAZ V., JULIA JOHANNSEN, STEFAN SCHWARZE: Proxy Means Tests for Targeting the Poorest Households: Ap- plications to Uganda	365
KAMAL EL-SIDDIG, SAHAR ABDALLA, MOIEZ FADUL, JENS GEBAUER, EIKE LUEDELING, ANDREAS BUERKERT: Baseline Mapping and Socio-Economic Analysis of Urban and Peri-Urban Agriculture (UPA) in Khartoum City, Sudan	366
TARIK RABIE, MOHAMED MANDOUR, HASSAN ZEWEIL: An Affordable and Effortless Method for High-Throughput DNA Extraction from Animal Tissues	367
MARTINA PREDOTOVA, JENS GEBAUER, LUDGER HERRMANN, EVA SCHLECHT, ANDREAS BUERKERT: Gaseous Carbon and Nitrogen Losses in Urban Gardening of Niamey, Niger	368

WaNuLCAS Modelling of Improved Swidden Agriculture Systems by Indigenous Fallow Management with *Melia azedarach* in the Uplands of Ban Tat, Northern Viet Nam

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In Viet Nam, economic development and demographic pressure has resulted in fragmented landscapes. Especially mountainous areas are prone to environmental degradation. Government efforts to stop shifting cultivation were not successful. Until today, many hill tribe communities apply swidden agriculture on upland fields. Nevertheless, indigenous knowledge created also useful adoptions to the local environmental setup. The Da Bac Tay minority group of Ban Tat, in northern Viet Nam intercrop *Melia azedarach*, a fast growing deciduous tree, at different stages of the swidden cropping cycle, to improve the restoration of soil fertility. The Centre for Agriculture and Ecological Studies (CARES) of the Hanoi Agricultural University carried out a long-term nutrient balance analysis of selected local cropping systems. In this context, on plot erosion and run-off measurements were conducted within a small watershed of the Ban Tat area. The assessment of long-term effects of such systems is often difficult to predict. Therefore, the objective of this study was to test the applicability of the Water, Nutrient, Light Capture in Agroforestry Systems (WaNuLCAS) model related to run-off and erosion under the local conditions of Ban Tat. Results and information based on farmer interviews of CARES were used to calibrate the model. Selected input parameters on agricultural management, climate, soil structure and topography were used for a sensitivity analysis and to define threshold values for the calibration process of the Ban Tat dataset. Three scenarios of the CARES experiments were used to validate model results. The scenarios represented the experimental setup related with the local swidden practices. WaNuLCAS predicted quite well the overall measured run-off of selected plots from 2000 to 2002 in total sum. The range of runoff in between the selected years was consistent in all scenarios compared to experimental measurements. Nevertheless, the model did not illustrate sharp declines of erosion in the second year as measured in the field. WaNuLCAS 3.2 can serve as useful tool to validate relationships of run-off and erosion within a selected setup of parameters. In general, model applications can help to understand the behaviour of a defined system, but should not be taken as authoritative statement per se.

Keywords: Biophysical modelling, indigenous fallow management, *Melia azedarach*, northern Viet Nam, swidden agriculture, uplands, WaNuLCAS

Scale Specific Adaptations of Drought Responsive Systems

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Water is an increasingly scarce resource and its availability is more and more erratic due to recent changes in rain fall patterns. Thus, agricultural systems suffer more often from drought or floods which leads to an demand for more flexible and plastic production systems. However, drought is a complex phenomenon that plants experience on a number of organisational levels or scales. Each scale can be viewed as an individual system, with specific adaptation potential to changing conditions. The highest organisation level is the agricultural system, followed by the field or individual crop scale. Down the line is the individual plant as a responsive system including tissue level systems as well as metabolic systems such as the proteome or the genome. This talk defines the different scales and their responsive potential, elaborates in examples the functioning of adaptation mechanisms on each scale and the interactions with factors other than drought influencing plant responses. The importance of long term and seasonal changes in the climatic environment, the effect and impact of erratic climatic events on the adaptation capacity of the respective system, responses to multiple stresses and varying degrees of stress severity are discussed using examples from recent experimental work. The requirements for modelling and in particular interfacing models for the different scales are elaborated. The talk concludes with the clear demand for inter- and multidisciplinary collaboration to better predict future changes in water availability and the plasticity of the respective systems. Developing a birds perspective in systems analysis without losing detailed expertise will expand the knowledge and thus exploitation potential of what is termed here as the gene-phene-scene continuum.

Keywords: Agricultural systems, climate change, gene-phene-scene-continuum, modelling, systems analysis

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Analysis of Vegetation Changes in High Andean Wetlands Using Remote Sensing as a Contribution to Environmental Planning in Southern Peru

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Wetlands of the high Andean mountains are exceptional ecosystems due to their hydrological characteristics in a surrounding arid environment. This group of tropical peat lands is situated in southern Peru, Bolivia and northern Chile and known as 'Bofedales'.

Bofedales provide a natural habitat which serve as grass land for South-American cameloids like Alpaca (*Vicugna pacos*) as a domesticated form of wild South American cameloid Vicuña (*Vicugna vicugna*) and Guanaco (*Lama guanicoe*).

The study area includes some of the greatest Bofedales of southern Peru as part of a national reserve (La Reserva Nacional Salinas y Aguada Blanca). One problem for reserve managers and decision makers of communities is the need of low cost, current and accurate information upon which they can base their decisions. Important questions are e.g.: 'What are the effects of pasturing, irrigation and drainage and how effective is protection of Bofedales?' 'What are the services which they provided and how could they be evaluated?'

The availability of no-cost data (e.g. MODIS) and automated data processing techniques can provide a cost effective tool to answer those questions.

The study shows that using high resolution data like Landsat ETM+ combined with elevation models derived from SRTM data (Shuttle Radar Topography Mission) clearly improves existing wetland classifications. It shows Bofedales as an inhomogeneous land cover type due to different characteristics mostly depending on relief, geology and climate. To investigate this inhomogeneity time analysis using the vegetation index (NDVI) is applied and compared with other vegetation cover types situated in the same study area.

Due to the different geometric resolution of the data (Landsat, MODIS, SPOT Vegetation) the potentials of subpixel classification for improving the accuracy of time analysis is investigated. Dependencies between climate, hydrological conditions and changes of vegetation are examined by using reanalysed climate data sets combined with hydrologic models.

Recommendations and conclusions are aimed to emphasise the need for research because much more work is required to develop resource management and conservation programs based on scientific research to ensure protection and sustainable use of Bofedales and therefore to ensure the future livelihoods of the indigenous peoples who depend on them.

Keywords: Landsat, MODIS, NDVI, remote sensing, SPOT Vegetation, SRTM, time analysis, vegetation change, wetlands

Estimation of Carbon Balance in Drylands of Kazakhstan by Integrating Remote Sensing and Field Data with an Ecosystem Model

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A monitoring system based on the use of remotely sensed derived data and quantitative information from field investigations was developed for estimation of carbon balance in drylands of Kazakhstan. In this system, carbon fluxes were derived from the combination of incoming solar radiation, Leaf Area Index (LAI) computed from the Normalized Difference Vegetation Index (NDVI) resulting from the data of SPOT-Vegetation satellite, and a biological conversion factor known as Light Use Efficiency (LUE) which describes the ability of vegetation to convert light energy into biomass. The amount of incoming solar radiation and its photosynthetically active part (PAR) was computed from the variables of Earth-Sun distance, solar inclination, solar elevation angle, geographical position and cloudness information of localities at a daily time-step and then summed to 10-day values. The product of this calculation was corrected for slope and aspect using a Digital Elevation Map. The fraction of PAR absorbed by plant canopies (fPAR) was estimated from 10-day maximum values of NDVI. A LUE value for every vegetation type was obtained through calibration of peak biomass data collected from a number of test sites against the amount of PAR computed for each of these locations. The LUE was reduced from the computed optimum value by modifiers dependent on atmospheric vapour pressure deficits and temperature. Separation of above-ground and under-ground biomass production was made using a root-shoot ratio computed from field measurements for each vegetation type. Autotrophic respiration was estimated by a quantitative approach described in recent literature. All modelling results were converted to carbon amounts using factor 0.47 and then to fluxes. The end outputs of the monitoring system were maps of assimilation, respiration and stocks with a spatial resolution of 1-km and 10-day time-step. The regional monitoring system allows detailed information on an area-wide carbon balance to be extracted using remote sensing and ground truth data. Our model can be used to quantify carbon stocks and flows over the whole territory of Kazakhstan and can serve as a basic assessment system for annual reports for the Kyoto Protocol signed by the Government of the Republic of Kazakhstan in 2003.

Keywords: Carbon estimation, drylands, Kazakhstan, NDVI, remote sensing

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Spatial Expansion of Urban Agriculture in Khartoum, Sudan

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The population of Khartoum has exploded during the past century, from about 300,000 in 1955 to approximately six million today, and continues to grow fast. A rapidly increasing food demand in the city and limited opportunities for crop production in the arid surroundings of Khartoum made urban production of agricultural commodities economically attractive. The objective of this study was to quantify the expansion of urban agricultural area from the city's colonial past to the present.

We derived the agricultural area within Greater Khartoum (comprising the three cities of Khartoum, Khartoum North and Omdurman) from scenes captured by scanners of Landsat satellites in the fall of 1972 (Multispectral Scanner — MSS), 1987 (Thematic Mapper — TM) and 2002 (Enhanced Thematic Mapper Plus — ETM+). For each dataset, the Normalized Difference Vegetation Index (NDVI) was calculated, and all grid cells with NDVI values higher than one standard deviation above the mean were classified as vegetated land.

To extend our time series further into the past and future, we quantified vegetation on a greyscale mosaic of aerial photographs taken in 1958, and on a recent satellite image downloaded from Google Earth. While image processing options on the greyscale image were limited, we extracted the green band from the recent image and interpreted all areas with green values smaller than a third of a standard deviation below the mean as vegetated. To exclude natural vegetation and, in the recent image, water bodies, we roughly sketched the outline of all major agricultural regions of the city, and interpreted the vegetated area in these polygons as active agricultural land.

The agricultural area of Khartoum, as detected by our analysis, amounted to only 4799 ha in 1958, but increased rapidly to 8751 ha in 1972, 10501 ha in 1987, 12920 ha in 2000 and 13249 ha today. In spite of the conversion of much agricultural land to residential and commercial areas, agriculture in the city has kept expanding. Along the banks of the Nile, agricultural areas have persisted, whereas many irrigation schemes further inland have been pushed into the peri-urban region.

Keywords: Aerial photography, Landsat, remote sensing, Sudan

Calibration and Validation of SWAT Hydrological Model for Meki Watershed, Ethiopia

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The Soil and Analysis Tool (SWAT) is a continuous time, physically based, and spatially distributed public domain hydrological model. SWAT is used in different tropical watersheds and reported to be able to well explain watershed hydrological processes. To benefit from its free accessibility and good modelling capability, testing this model for the Ethiopian condition is necessary. The Meki Watershed, covering an area of 2233 km², is found in central Ethiopia and has an average elevation of 2143 m.a.s.l. Before calibration, baseflow separation and sensitivity analysis was carried out. It is found that 62 % of the flow is contributed by the baseflow. The sensitivity analysis showed that from 28 parameters controlling the flow, only 14 revealed meaningful effects on the flow simulation. The curve number (CN₂), the soil available water capacity (SOL_AWC), and the soil evaporation compensation factor (ESCO) are the most sensitive of all controlling the surface flow. For the baseflow, threshold water depth in the shallow aquifer for flow (GWQMN), saturated hydraulic conductivity (sol_k), deep aquifer percolation fraction (rchrg_dp), and groundwater revap coefficient (GW_REVAP) have the highest influence. The flow was manually calibrated using monthly gauged and simulated flows from 1985 to 1989. At first, the surface flow and then the baseflow were calibrated. Then, the total flow was compared. Validation was done for flows from 1990 to 1992 following the same procedure but without changing any of the calibration parameter values. The calibration result showed that there is a good agreement between the simulated and gauged monthly flows. This is demonstrated by the correlation coefficient ($R^2=0.84$) and the Nash-Suttcliffe simulation efficiency (ENS=0.69) values. For validation, the R^2 was found to be 0.81, which showed its very good correlation with the gauged flow. The ENS value that was found to be 0.54, though relatively lower, is acceptable as this value is more than 0.5. The results showed that SWAT is able to simulate the hydrological characteristics of the watershed very well.

Keywords: Baseflow, baseflow separation, correlation coefficient, modelling, nash-suttcliffe simulation efficiency, sensitivity analysis, soil and water analysis tool, surface flow

Mapping Land Cover Changes and Agricultural Transformation Processes in Cambodian Upland Regions with its Spatial Impact on Smallholder Food Production

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Cambodian agriculture bases predominantly on rice production of small farmer communities currently employing approximately 80 % of the economically active population. Over the last 10 years, major agricultural activities in Cambodian upland have changed from mainly swidden and shifting cultivation of smallholders to large-scale economic land concessions and the restitution of already existing plantations. Substantial investments into modern agricultural production techniques as well as a conversion of subsistence farming methods into market oriented crops have been transforming the land use systems in several Eastern and North-Eastern provinces of Cambodia, namely Kampong Cham, Mondulhiri, Kratie, Stung Treang and Ratanakiri. Ongoing in-migration of landless farmers into these upland provinces are observable, due to rising agricultural job opportunities and fertile soil conditions, especially in basaltic areas of Kampong Cham, Mondulhiri and Ratanakiri. In the first years landless migrating farmers tend to become contracted by agricultural companies, while parallel they encroach open and degraded forest areas as well as unused or non-occupied land next to the concession land. Increasing regional population and primarily non-food agricultural production of rubber, cashew and cassava force the existing small-scale food production systems either to convert into intensification or to extend the cropping area, which mostly takes place.

Supported by remote sensing interpretations of Landsat TM and Spot satellite images as well as aerial photos of selected research areas, a description and detailed information and regional maps of particular land cover and land uses changes is presented. The project identifies and classifies the observable process of land use change and its particular conditions applying the up-to-date Land Cover Visualisation and Analysis Tool algorithm of the USGS.

Project results information as well as recent land cover maps and land uses advice will be offered to ongoing national and regional land use planning activities in selected provinces and districts.

The results will also be included into the agricultural extension service as supplementary information to improve regional selection of extension target areas and communes. Project findings are of significant additional interest to strategic district development issues and the commune based natural resource mapping activities (CCB-NREM) in Cambodia.

Keywords: Aerial photo interpretation, agricultural transformation processes, Cambodia, land cover changes, remote sensing, South-East-Asia

Lessons Learnt from Three Social Accounting Matrices

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The social accounting matrix (SAM) is a comprehensive disaggregate, consistent and complete data system that captures interdependences existing within a socioeconomic system. While the disaggregated version of the SAM represents the database for the computable general equilibrium (CGE) analysis, and the aggregated version is a step to building the disaggregated SAM, this study seeks lessons from the aggregated versions taking three SAMs (2002, 2003, and 2004) for Sudan. The three SAMs are built at the same level of aggregation each with ten main sectors; activities, commodities, factors of production, government, tariff, non-tax revenue, firms, capital account, and the rest of the world. A comparison of these SAMs gives many lessons about the progress of the Sudanese economy. The commodities account which includes exports and imports, took the top position for the three years with an increasing trend (16%) reflecting the effect of oil as a growing component in the economy. This was followed by the accounts for activities and factors of production with 18% and 23% respectively. The household took the fourth position with no significant change between 2002, and 2003, and with 17% improvement in 2004. The accounts of the rest of the world and government showed no significant change between 2002 and 2003, but between 2003 and 2004 they changed by 60% and 76% respectively, reflecting the impact of the Darfur conflicts which started in 2003. Firms and capital accounts recorded the strangest behaviour with 6% and 91% deterioration respectively in 2003, and improvements of 493% and 1227% respectively in 2004. This is explained on the basis that private sector and investments are sensitive to the country's stability. Slight increases occurred in the trend of tariffs, indicating some steps on the way of globalising the terms of trade. The share of agriculture as a major component to the gross domestic product (GDP) is fluctuating since the oil extraction in 2000, showing 36%, 35.8%, 37.5%, 36.5%, and 32.5% for the years 2000–2004. More details on how agriculture is affected by other economy sectors will be shown in the full version of the paper.

Keywords: Agricultural sector, macroeconomic policy, SAM

Assessing the Potential of Floodwater Harvesting in Seleit Area Wadis, Sudan - Using Remote Sensing and GIS

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Seleit Area constitutes the northeastern part of Khartoum state in Sudan. It is located between 32° 31' - 33° 00' E and 15° 45' - 16° 00' N; and has an area of 1,150 km². The area is a flat plain with some scattered cropouts. It is of a semi arid climate, where the spatial variation in amount and duration of rainfall during the rainy season is dominant (average annual rainfall 120 mm), with sparse vegetation. About 80 % of the area is dominated by the rangeland with little cultivation near the Nile and in the courses of the wadis (ephemeral seasonal streams). The main wadis of this region are El Kangar, El Seleit, El Jaili, and El Kabbashi. The area experienced destructive flash floods due to rainstorms with high intensity and short duration in addition to the sparse vegetation. During the years 1988, 1994, 1998 and 2001, the area was subjected to severe flash floods that left huge losses for the settlement there. The assessment of the potential floodwater harvesting in the area was carried out using the NAM Rainfall-Runoff model to estimate the potential runoff. The watersheds of the four wadis were defined and calculated using ArcHydro. The areas of wadi El Kangar, El Seleit, El Jaili and El Kabbashi are found to be 554.36 km², 398.25 km², 114.17 km², and 57.48 km², respectively. The potential of the water volume for the individual rainstorm was calculated. The runoff for the maximum annual rainfall for wadi El Kangar, El Seleit, El Kabbashi and El Jaili are found to be 1530.213, 1048.119, 163.1, and 321.784 (m³/s) respectively. The Remote Sensing and GIS were used to define the wadis of the study area downstream and to localise the WH sites. They found to be of great help for data preparations and for decision making. The study came to a conclusion that the potential of water harvesting in the study area exists. Implementing such systems could open new environments for permanent and better settlement conditions as well as new opportunities for sustainable development.

Keywords: ArcHydro, flash floods, floodwater harvesting, GIS in hydrology, NAM model, remote sensing, wadis, watershed

Contribution of Gum Arabic Production to Household Food Security in North Kordofan, Sudan

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Gum arabic is one of the main crops produced in the traditional rain-fed agricultural sub-sector in North Kordofan State, Sudan. It is a major non-timber forest product of the genus *Acacia*; namely *Acacia senegal* L., locally called “Hashab tree”. It contributes significantly to export crop portfolio in Sudan. Most of gum producers across the Gum-belt of North Kordofan experience a situation of food insecurity. The marketing system of gum arabic consists of three sub-systems; these are the rural traditional, the auction and the export market. The latter is dominated by the Gum Arabic Company (GAC) and other oligopoly-processing companies. The rural traditional market comprises small producers and village merchants. In this market, the producers are offered either low prices or given supplies much lower in value compared to their gum harvest. The traders and middlemen who act as a link between producers and the gum companies permit collusive arrangements, thereby allowing them to undercut producers’ prices.

Using some remote sensing and GIS techniques, the present paper displays some of the most risky gum production areas with regard to household food insecurity in North Kordofan. Such areas fall in the ‘transition’ Gum-belt between the war-affected south and the drought-affected north.

In order to investigate the prevailing conditions, the contribution of gum arabic as cash crop rotated or intercropped with other crops was highlighted. Using the Policy Analysis Matrix (PAM) as an empirical technique, the paper was able to elaborate the effect of policy interventions (e.g. producer floor price) and market distortions (monopsony, oligopoly) on income disparities between gum producers and other beneficiary groups. Having established these dimensions, the paper suggested some recommendations that can be used as a nucleus for improving household food security in gum arabic production areas of North Kordofan.

Keywords: Food insecurity, market distortions, Policy Analysis Matrix (PAM), policy intervention, gum

Exploring Land Use Systems in Rural Settlements, Upper Egypt: Combining Biophysical Possibilities and Socioeconomic Goals

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The ambitious project of desert land reclamation in Upper Egypt is only possible if settlers can develop a sustainable agriculture, with effective water saving allocation schemes. According to the Lake Nasser Development Project (LNDP) the total Nile water requirements for irrigation will reach 41 billion $\text{m}^3 \text{yr}^{-1}$ once all on-going land reclamation projects are completed. The drinking and industrial water requirements in the medium term will reach 10 billion $\text{m}^3 \text{yr}^{-1}$. The volume evaporating from the Nile is estimated as of 1.3 billion $\text{m}^3 \text{yr}^{-1}$, being the total allocation of water for Egypt 55.109 $\text{m}^3 \text{yr}^{-1}$, around 3 billion $\text{m}^3 \text{yr}^{-1}$ will still be available. According to this figures, it is imperative that the water allocation in the new lands be as efficient as possible. Another important aspect is the environmental fragility of the region around the Lake Nasser, the use of agricultural inputs like fertilisers and biocides should be minimised or even avoided. Alternative land use systems are needed, which achieve higher yields and returns to water ensuring zero nutrient depletion of soils and no environmental damage. The desert reclaimed lands have mineral rich soils that need a supply of organic matter through manure, in order to improve their fertility, water retention and structural quality. There is still a very poor integration of the livestock activities and agriculture (fodder cultivation and husbandry), despite the advantages for improvement of poor soils organic matter content and also for families self-sufficiency in food. The objective of this land use study is to explore solutions for the above problems searching for organic cropping alternatives that are simultaneous biodiversity enhancing, through the implementation of an integrated bio-economic farm model. The model aims to combine linear programming techniques with agronomy-based crop growth simulation models like CropSyst. The inclusion of agronomy-based models enlarges the flexibility and exploratory power of the model. It allows the exploration of more efficient and sustainable land use systems, e.g. systems that are constrained for zero-soil nutrient depletion and zero environmental emissions, e.g. nutrient balancing.

Keywords: CropSyst, linear programming, optimisation

Performance Measurement of Farming Systems in Resource Management Using Non-Parametric Model – A Case from North Syria

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Many studies and researches show that when water is available for irrigation, there is an increase in use of other production inputs such as labour and capital in farm activities. This may lead to inefficient use of other production inputs in farm activities resulting to a significant reduction in the farm income of the farming families. In this study, efficiency use analysis of the available resources was carried out in two farming systems.

1. First farming systems (FS1) that do not experience water scarcity.
2. Second farming system (FS2) that experience water scarcity.

The two farming systems are mainly differentiated by source and availability of water resources. There is no significant difference in availability of other resources between the two farming systems.

To analyse technical efficiency of the available resources, Data Envelopment Analysis (DEA) method was used. This method applies two models which are constant return of scale and variable return of scale. The first model was used for analysis in this study.

Results showed that in both farming systems, technical efficiency of resource utilisation was better in cotton and vegetables cultivation as compared to wheat, maize and sunflower cultivation. Results also show that the average technical efficiency in FS1 was 70.6 % and 73.25 % in FS2. Technical efficiency is higher in FS2. Due to water scarcity, these farmers have reduced utilisation of production inputs such as capital and labour in farming activities and diverted them to off-farm activities. On the other hand, due to adequate water for irrigation, farmers in FS1 have over utilised their production inputs thus lowering technical efficiency in farm activities.

Despite a lower technical efficiency in farm activities, farmers in FS1 achieved higher farm income than FS2. However, the difference is not significant. Although farmers in FS2 have less water, they managed their resources better than FS1. Therefore the farm income of both farming systems was almost equal.

Keywords: DEA, farming system, performance, Syrien

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Proxy Means Tests for Targeting the Poorest Households: Applications to Uganda

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The motivation for this research stems from increasing interest exhibited toward the issue of targeting. This paper explores the use of proxy means tests to identify the poorest households in Uganda. The set of indicators used in our model includes variables usually available in Living Standard Measurement Surveys (LSMS). Previous researches seeking to develop proxy means tests for poverty most often use Ordinary Least Squares (OLS) as regression method. In addition to the OLS, the paper explores the use of Linear Probability Model, Probit, and Quantile regressions for correctly predicting the household poverty status.

A further innovation of this research compared to the existing literature is the use of out-of sample validation tests to assess the predictive power and hence the robustness of the identified set of regressors. Moreover, the confidence intervals are approximated out-of sample using the bootstrap algorithm and the percentile method.

The main conclusion that emerges from this research is that measures of relative poverty estimated with Quantile regression can yield fairly accurate in-sample predictions of absolute poverty in a nationally representative sample. On the other hand, the OLS and Probit perform better out-of-sample. Besides its complexity, the Quantile regression is less robust. The Probit may be the best alternative for optimising both accuracy and robustness of a poverty assessment tool.

The best regressor sets and their derived weights can be used in a range of applications, including the identification of the poorest households in the country, the assessment of poverty outreach of Microfinance Institutions (MFIs), the eligibility to social transfer programs, and the measurement of poverty and welfare impacts of agricultural developments projects. Finally, findings from this paper could complement the use of poverty mapping for geographically targeting the poor.

Keywords: Bootstrap, out-of-sample test, poverty assessment, proxy means test

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Baseline Mapping and Socio-Economic Analysis of Urban and Peri-Urban Agriculture (UPA) in Khartoum City, Sudan

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Urban and peri-urban agriculture (UPA) is the growing of plants and raising of animals for food, feed and other uses, and related processing and marketing activities, within and around cities and towns. UPA has received increased attention in the past few years from development organisations and national authorities in developing countries. It plays an important role in poverty alleviation, food security and waste management. In spite of this, there is very little information on UPA in Khartoum, the capital city of the Sudan. Thus, one of the main objectives of the UPA project, sponsored by the Alexander von Humboldt foundation, is to produce a baseline mapping and socio-economic analysis of agricultural activities in Khartoum city. Agricultural production in Khartoum is categorised into two farming systems on the basis of the location, and used as units of investigation: urban and peri-urban. Satellite images in combination with geographic positioning system (GPS) were successfully used to determine the actual extend of inner and outer city areas used for agricultural purposes, and the spatial distribution of such areas. The information collected include household demographic data, access to land, water resources for cultivation, assets and livestock, manure sources, cropping calendar, output data, marketing access and constraints to production. It is expected that the study will present a clear overview of UPA in Khartoum by documenting its scale and extent, its role in food security, poverty alleviation, public health and sustainable resource management. Furthermore, during the later phases of the project nutrient flows will be quantified for a number of urban and peri-urban farms. The knowledge obtained will allow for an integration of bio-physical and socio-economic data in modelling urban and peri-urban biomass and nutrient flows, which is a prerequisite for resource-efficient agricultural production.

Keywords: Baseline mapping, Khartoum city, socio-economic analysis, urban agriculture, peri-urban agriculture

An Affordable and Effortless Method for High-Throughput DNA Extraction from Animal Tissues

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A very simple and inexpensive method for high-throughput DNA extraction from animal tissues has been developed. The procedure contains three steps (digestion, Incubation, and centrifugation) and it is compatible with the normal eppendorf tubs which are commonly used in the routine laboratory work. A small piece of tissue (from 10—400 mg) was used to isolate DNA. It yields enough templates DNA for polymerase chain reaction (PCR) amplifications (at least two complete 96 well PCR plates). Enormous number of sample are used to establish the final procedure for DNA isolation from chicken, duck, and quail for different kind of tissues such as Heart, Liver, Spleen, Pancreas, Kidney, Stomach, Gizzard, Oviduct, Ovary, Testes, Bronchi, Lung, brain, and Pituitary gland. DNA purity and concentration have been measured by NanoDrop® Spectrophotometer and the standard curve was drawn. Both microsatellite (MCW0166, MCW0317 - derived from chicken linkage map- , SCU00100, and SCU00101-not published) and STS markers (Randomly selected STS marker from National Center for Biotechnology Information, NCBI) have been used to examine the isolated DNA by normal PCR. Agarose gel electrophoresis (different concentrations ranged as 1, 1.5, and 2 %) has applied successfully, followed by 8 % and 10 % polyacrylamide gel to emphasise the viability of extracted DNA for several molecular biology applications. DNA marker ranged from 50bp-1000bp was used as a guide for the PCR product size resulted in variable range of band sizes. Therefore, this application method is expected to facilitate studies that require high-throughput DNA isolation for PCR amplification, such as genotyping by microsatellite markers for mapping and genetic diversity studies, as well as mutant screening in poultry.

Keywords: DNA isolation, large-scale screen, microsatellites, polymerase chain reaction, poultry, tissues

Gaseous Carbon and Nitrogen Losses in Urban Gardening of Niamey, Niger

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Calculations of horizontal input and output balances in urban agriculture (UA) of Africa and Asia have indicated large nutrient surpluses whose fate, however, remains unclear. An INNOVA photo-acoustic infrared multi-gas monitor was used over 12 months to quantify gaseous emissions of CO₂, CH₄, NH₃ and N₂O in UA systems of Niamey, Niger. Measurements with the closed chamber system were taken in triplicate once every month for 10 min during the coldest (6–7:30 am) and hottest (13–14:30 pm) part of the day.

Morning ambient temperatures were 10–15°C in December and reached 30°C during the hot dry season (April–May). Afternoon temperatures peaked during the hot dry season at 48°C and dropped to 29–33°C in December. In the morning soil moisture at 6 cm depth varied from 0.2–14.6 vol% during the hot dry season and from 19.3–47.3 vol% in the rainy season. In the afternoons soil moisture reached 21 vol% in the hot dry season and 54 vol% in the rainy season.

Emissions of NH₃-N and N₂O-N and CO₂-C and CH₄-C were highest at the end of May and in August 2006. During these days the respective afternoon maxima reached 48 and 25 g N ha⁻¹ h⁻¹ and 6815 and 734 g C ha⁻¹ h⁻¹. The high flux rates at the onset of the rainy season were likely due to higher soil moisture and a man-made high nutrient concentration in the topsoil during these measurements, which preceded the next cropping season.

Extrapolated average morning emission rates of 21 kg N ha⁻¹ a⁻¹ and 20 490 kg C ha⁻¹ a⁻¹ and afternoon rates of 85 kg N ha⁻¹ a⁻¹ and 29 800 kg C ha⁻¹ a⁻¹ were up to two-fold higher than reported from irrigated oasis soils in Oman. These losses may be partly due to excessive fertilizer inputs and partly to ineffective nutrient management. In addition to the high volatilisation rates, on the sandy garden soils nutrient losses from leaching during the rainy season are also expected to be high but have not yet been quantified.

Keywords: Carbon, gaseous emissions, Niger, nitrogen, urban agriculture

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New applications of modelling

Oral Presentations	371
GIUSEPPE FEOLA, CLAUDIA R. BINDER: Integrated Modelling of Farmers' Decision Making on Pesticides' Use: The Case of Vereda La Hoya, Colombia.	371
TINNE VAN LOOY, ERIK MATHIJS, ERIC TOLLENS: Development and Application of a Bio-Economic Agroforestry Model for the Tropics	372
MATTHIAS LANGENSIEPEN, STEPHEN BURGESS, PATRICK MITCHELL: Quantifying the Heterogeneity of Transpiration Fluxes from Tree Crowns: Results from a Case Study on <i>Eucalyptus</i> Trees in the West-Australian Wheat-Belt	373
ALWIN KEIL, NILS TEUFEL, DODO GUNAWAN: Modelling the Impact of El Niño-Related Drought on Smallholder Farmers in Central Sulawesi, Indonesia: An Interdisciplinary Approach Combining Climatic and Hydrologic Modelling with Regression Analysis and Linear Programming	374
Posters	375
BYRON MAZA: Decision Making Models for Cattle Ranchers with Respect to Land Use Change and Silvopastoral Systems Adoption in Costa Rica	375
THOMAS GAISER, KARL STAHR, ANDREAS PRINTZ, VICTOR DUKHOVNY: Development of a Regional Model Integrating Land and Water Management - Achievements and Lessons Learnt	376
PAVEL PROPASTIN, STEFAN ERASMI, MARTIN KAPPAS, OLEG PANFYOROV: Remote Sensing Based Investigation of Vegetation Response to the El Niño Caused Drought Conditions over Indonesia	377
OGHAIKI ASAAH NDAMBI, OTTO GARCIA, TORSTEN HEMME: Enhancing Agricultural Sustainability in Africa: Evaluation Tools for Assessing Policy Impacts on Dairy Farming	378

LAZARE TIA, JOERG SZARZYNSKI, PAUL L. G. VLEK: Ecological Modelling of Tree Patterns and Diversity as a Means of Classifying Savannah Landscapes: Remote Sensing and GIS-Based Mapping	379
YAN LIU, JIANCHUN GUO, YOUPENG KE: Study on Hainan Provincial Environmental and Resource CGE Model	380
NEDUMARAN SWAMIKANNU, BEKELE SHIFERAW, K. PALANISAMI: Integrated Crop-Livestock Bioeconomic Modelling Approach for Assessing the Impact of Productivity Enhancement Tech- nological Interventions on Economic Performance, Soil Ero- sion and Nutrient Flow at Micro Watershed Level	381

Integrated Modelling of Farmers' Decision Making on Pesticides' Use: The Case of Vereda La Hoya, Colombia.

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Pesticides' use in agriculture poses serious threats to human health and the environment in rural areas especially in the least developed countries. As a consequence, a transition to a more sustainable use of pesticides is required. This implies a full understanding of the farmers' decision-making process, which is embedded into social structures and the environmental context and, conversely, affects them. Most of the behavioural models developed have focused mainly on socio-economic (e.g. education, wealth) or environmental variables (e.g. soil characteristics) or risk-perception. An integration of psychological, socio-economic and environmental factors has rarely been pursued in these approaches.

We present a behavioural model, aiming at bridging this gap and understanding the farmers' decision-making process. The model relies on the Theory of Interpersonal Behaviour (H.C. Triandis) and the Structuration Theory (A. Giddens).

In this model, farmers' behavioural options are defined as quantity and typology of pesticides applied and choice of using safety practices. The probability of farmers' behaviour is influenced by internal and external drivers. The internal drivers include intention and habit whereas the external ones consist of contextual factors, e.g. weather conditions, soil characteristics, prices of products. Intention itself is determined by: **i)** attitude (the product of beliefs about the outcomes), **ii)** subjective culture (product of individual/collective norms and roles) and **iii)** affect (the feelings associated with the act). Farmers' actions have desired consequences such as avoiding yield losses, and unintended consequences such as health and environmental impacts. These consequences give birth to a double feedback loop, i.e. towards internal and external behavioural drivers, consequently influencing the decisions in the future.

Thus, the model is able to integrate multiple levels of analysis (individual, collective) and dimensions (social, economic, environmental), providing the basis for a comprehensive quantitative analysis of the decision-making process.

We will present the conceptual framework of the model and show how it can be operationalized for the case of pesticide management in Vereda la Hoya, Colombia. In particular we will focus on how the link between environmental and health aspects and farmers decision-making can be analyzed. First insights into weaknesses and strengths of the selected approach will be presented.

Keywords: Behavioural model, decision-making, pesticide

Development and Application of a Bio-Economic Agroforestry Model for the Tropics

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In the past 15 years biological and bio-economic agroforestry models have been developed for yield and profitability predictions. Biological models use complicated mathematical equations to model specific biological interactions. Bio-economic models combine simplified mathematical equations with economic calculations for discounted cost-benefit analyses. The paper describes the development, use and potential extensions and improvements of a bio-economic model, specifically developed for tropical agroforestry trials. The tree component are farmer-selected indigenous fruit-producing species. Hence, species specific growth functions, as used in a bio-economic model predicting rubber yields in South East Asia, could not be used. Moreover, by using growth functions one cannot account directly for interaction effects. This deficiency was overcome by using mathematical equations, analogous to FarmSAFE, a bio-economic model predicting profitability of agroforestry systems with wood producing tree species in Europe on plot and farm level. Equations modelling water competition in FarmSAFE are replaced for equations modelling nutrient fluxes, as this interaction effect is more prevalent in a (sub-)humid tropical climate. As in FarmSAFE, equations modelling light competition are included. Predicted biomass production is divided over stored woody biomass and yearly fruit production. Species specific parameters are used to calculate net present values of various agroforestry systems, recently planted in Venezuelan and Brazilian project villages. These are compared one to another and vis-à-vis the traditional systems prevailing in the area. First results show a positive profitability of the agroforestry system vis-à-vis the traditional system, in spite of increased labour demand. Further research should reveal to which extent an increase in profitability, which is an adoption enhancing factor, can compensate for an increase in labour pressure from a social point of view. The uncertainty of model predictions, due to a lack of time-series data, can partly be overcome by including stochastic distributions for key parameters. In the future the model will allow calculating bio-energy balances, as market prices of products with underdeveloped markets do not reflect the real value of agricultural production. This will allow for the comparison of the ability to strengthen food security, one of the MDGs, of the different agroforestry systems introduced.

Keywords: Net Present Value, non wood forest production, nutrient fluxes, under-utilised species

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Quantifying the Heterogeneity of Transpiration Fluxes from Tree Crowns: Results from a Case Study on *Eucalyptus* Trees in the West-Australian Wheat-Belt

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Trees and shrubs often grow in irregular patterns as opposed to uniform field crops. Fluxes of heat and mass as well as momentum exchange are more difficult to quantify under such conditions and require consideration of intra-canopy processes. A generic model has been constructed to simulate the heterogeneity of transpiration fluxes from non-uniform plant canopies. It was parameterised and tested in a natural *Eucalyptus* forest located in the centre of the West-Australian wheat belt, which is currently heavily affected by soil salinity due to inappropriate land management over the past decades. The general purpose of the study was to understand the water use patterns of the natural vegetation and to use this information to re-design agricultural systems. The model divides the canopy in three-dimensional cells called voxels and simulates their complete energy-balances. It was parameterised with respect to canopy architecture, stomatal response to light, vapour pressure deficit (VPD), leaf temperature and local water stress, as well as aerodynamic transport. Simulations of direct and diffuse radiation fluxes are carried out with a ray-tracing algorithm and canopy surface temperatures were determined by solving the energy-balance equation with the Newton-Raphson algorithm. Model outputs were compared against independent measurements of sap-fluxes using the heat-pulse technique. It produced highly accurate results on a seasonal scale, but initially failed in repeating diurnal measured transpiration. Recent results of branch-level transpiration simulations and corresponding sap-flow measurements will be shown, which were undertaken in the 2006/2007 season and lead to significant increases of the predictive quality of this model. These results suggest that mechanism governing changes of hydraulic tree structure must be considered more closely when simulating the heterogeneity of transpiration fluxes on a short time scale.

Keywords: Energy-balance, *Eucalyptus salmonophloia*, heterogeneity, modelling, plant architecture, plant-water relations, simulation

Modelling the Impact of El Niño-Related Drought on Smallholder Farmers in Central Sulawesi, Indonesia: An Interdisciplinary Approach Combining Climatic and Hydrologic Modelling with Regression Analysis and Linear Programming

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Crop production in the tropics is subject to considerable climate variability caused by the El Niño-Southern Oscillation (ENSO) phenomenon. In Southeast Asia, El Niño causes comparatively dry conditions leading to substantial declines of crop yields with severe consequences for the welfare of local farm households. Using a modelling approach that combines regression analysis with linear programming and integrates climatic and hydrologic modelling results, the objective of this paper is to assess the impact of El Niño on agricultural incomes of smallholder farmers in Central Sulawesi, Indonesia, and to identify suitable crop management strategies to mitigate the income depressions. The results contribute to the formulation of enhanced development policies and provide guidance for future research activities.

Based on resource endowment and location within the mountainous research area, we identified five classes of smallholder farms by cluster analysis. Our linear programming model maximised their cash balance at the end of the six-month period most severely affected by El Niño. Main activities were the cultivation of rice, maize, and cocoa, for which external Cobb-Douglas production functions were estimated that include water supply as an input factor; they generate output according to level of production intensity as well as predicted weather patterns.

The results illustrate that, even within a relatively small geographic area, advisable crop management strategies diverge between different types of farm households during El Niño events, depending on the micro-climatic and hydrologic characteristics of their location, the farming system, and resource endowment. Hence, related recommendations and policy measures need to be carefully tailored according to these factors if they are to be effective and economically efficient.

Keywords: El Niño, Indonesia, interdisciplinary modelling, linear programming, risk management

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Decision Making Models for Cattle Ranchers with Respect to Land Use Change and Silvopastoral Systems Adoption in Costa Rica

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The research developed several decision making models with the objective to contribute to one of the objectives of the socioeconomic component of the GEF project “Determine the effect of environmental service payments (ESP) over the decisions making process in the farm and determine the factors that influence adoption of sustainable land use systems”.

The final model is a non-linear optimisation model which identifies the optimal land use change allocations using profit maximisation for land use at the farm level. This model used real assumptions of credit access, family labour, initial capital availability and pasture areas. An assumed strength of the model is that the farmers maximise their benefits. Even though the farmers do not maximise their decisions the same way, the model shows trends in land use change similar to real tendencies. This model is dynamic and deterministic and made by MatLab™ software. It provides a practical way to achieve the objective of evaluating the impact of external and internal factors as well as the environmental service payments on land use and adoption of silvopastoral systems. The model shows that with base simulation conditions for medium farms, there is a positive effect of ESP incentives on more environmental friendly land use change (SPS). The greatest land use changes are due to natural or improved pastures. The effect of ESP in the base simulation was conditional for the absence of credit access and low capital. If the farm has access to credit and more initial capital, the land use will occur even without ESP. This shows the interest of ESP to remove the capital barriers. Environmental service payments did not effect small farms as the current ESP amount is insufficient. On the large farms, there are land use changes without the necessity of ESP. That is to say the current amount of ESP is not necessary. An increase in the current amount of ESP could overcome the financial barriers for tree introduction. A 3 times increase in the 2-year ESP scheme will cause more changes and the largest changes will be towards pastures with high tree densities.

Keywords: Decision models, environmental service payments, land use change, optimisation model

Development of a Regional Model Integrating Land and Water Management - Achievements and Lessons Learnt

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The project “RIVERTWIN” developed, adjusted and tested a framework for an integrated regional model to be used for the strategic planning of water resources management in river basins under contrasting ecological, social and economic conditions. Target river basins were located in Germany, Uzbekistan and Benin Republic. The project tested and validated nine submodels covering different aspects of water and land management for assessing the effect of defined scenario options. Seven of the submodels tested in the Neckar basin were successfully transferred to the Oueme basin (Benin, West Africa) including the integration framework MOSDEW (MOdel for Sustainable Development of Water resources). Five of the submodels were transferred and adapted to the Chirchik-Ahangaran-Keles basin (Uzbekistan, Central Asia) and complemented with additional four models (HBV-GAMS, SEM, IRR_SYS, WAVE) which take into account the specific hydrological and water allocation conditions in this basin which are (1) heavily modified water fluxes in the lower part of the basin with reservoirs and a complex channel network (2) interconnection with two smaller basins (Ahangaran, Keles) and (3) strong competition for scarce water resources by different user groups (agriculture, energy production, ecology). The specific setting requires a dynamic integration interface which takes also into account feedback between water availability and water consumption. This requirement was met by the adapted model version MOSDEW-Chirchik.

In each river basin the developed model framework was used to perform simulation runs of scenario options which has been previously defined in cooperation with relevant stakeholder groups and to quantify their impact on selected water and land use indicators. The scenario options take into account global and regional climatic changes as well as socio-economic perspectives and interventions in the water and agricultural sector. In each basin, the results of the scenario calculations were evaluated and discussed in public stakeholder workshops.

Keywords: Benin, integrated regional model, land and water management, Uzbekistan

Remote Sensing Based Investigation of Vegetation Response to the El Niño Caused Drought Conditions over Indonesia

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El Niño Southern Oscillation (ENSO) is a widely acknowledged global climatic phenomenon caused by a rapid increase of sea surface temperature in the tropical Pacific. The ENSO phenomenon mainly affects the coastal areas of tropical and subtropical climate zones. One of these effects is the redistribution of rainfall from Indonesia, New Guinea and Australia into the Pacific and to the Pacific coast of South America. This redistribution leads to drought conditions in wide areas of South-East Asia and as a consequence of drought to agricultural yield decreases and food shortage. The goal of this study was to investigate and to quantify the relationship between variability of ENSO and drought events over Indonesian archipelago. This relationship was investigated by the examination of month-to-month correlations between standardised anomalies of the Normalized Difference Vegetation Index (NDVI) and two ENSO indices, Sea Surface Temperature Anomalies (SSTA) and Southern Oscillation Index (SOI). The results demonstrated that the total dimension of the territory affected by anomalous weather conditions caused by ENSO depends on the duration of a certain ENSO event. On the contrary, the magnitude of the NDVI anomalies is predicted by the intensity of the El Niño event. Thus, the total affected area for the 1997–98 ENSO was two times larger than that for the 1982–83 ENSO episode. However, the 1982–83 ENSO episode was shorter but more intense. The ENSO in 1997–98 was the longest event throughout the period of 1982–2003 but demonstrated a lower intensity that is characterised by lower correlation coefficients. The results of this study serve to a better understanding of the origin and driving forces of droughts in Indonesia and emphasises the importance of taking into account the El Niño duration and intensity when trying to evaluate the ENSO damage grade on the vegetation cover.

Keywords: ENSO, Indonesia, NDVI, remote sensing, vegetation response

Enhancing Agricultural Sustainability in Africa: Evaluation Tools for Assessing Policy Impacts on Dairy Farming

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Dairy production is an integral part of agriculture and contributes to 20 % of the agricultural GDP in tropical countries like Uganda. Dairying is a smart investment that can generate daily income and enable poor farmers meet up their immediate needs. Therefore, several developmental projects in Africa target dairying for poverty alleviation. Unfortunately, their predicted outcomes are compromised by poor understanding of dairy sectors. According to ILRI, the right policies, marketing systems and technical support must be sought for dairy development. Also, for selection of improved policies, adequate analytical tools need to be developed and applied, especially in typical African agricultural systems, where the farm, family and household are a very complex and hardly separable unit.

Two tools were applied for policy impact analysis, focusing on typical dairy farms in Uganda. Identification of stakeholders and policies affecting dairying, followed by ranking of these policies was done using the EXTRAPOLATE (EX-ante Tool for Ranking Policy Alternatives) model. Deeper policy impact analysis was done using the TIPI-CAL (Technology Impact Policy Impact Calculations) model, further developed in 2005 to suit its applicability on small-scale farms.

The EXTRAPOLATE model identified and ranked eight influential policy areas on dairying as follows: Provision of extension services, provision of veterinary services, consumption promotion, marketing promotion, input provision, credit access, quality improvement and genetic improvement. The TIPI-CAL model revealed that these policies greatly increase the household per capita income, including other non-cash benefits like increased household consumption, manure from animal dung, better family health and better social status. The impacts of the same policies were up to three times higher on farms with graded animals, compared to those with local ones. Though policy ranking differed slightly in both models, it was noticed that they greatly complement each other in explaining policy impacts on the livelihood of farmers and on the whole dairy chain.

This study further illustrates the importance of modelling in depicting the role of various stakeholders such as the government, national and international bodies in regulating or encouraging the allocation of land, labour, capital and expertise to promote sustainable agricultural development.

Keywords: Dairy farming, livelihood, policy impact, evaluation tools, modelling

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Ecological Modelling of Tree Patterns and Diversity as a Means of Classifying Savannah Landscapes: Remote Sensing and GIS-Based Mapping

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Through its control of energy fluxes over substantial portions of the land surface, vegetation is an important component of the global climate system. In semi-arid regions, issues of rainfall reduction, climate change, and water scarcity are aggravated by the increasing disturbance of the natural relationship between vegetation and climate. Even the role of disturbing dominant vegetation types has not yet been comprehensively studied. The current paper focuses on the spatial distribution of the savannah physionomy and phytosociology in relation to environmental factors such as soil types and land units, to establish an accurate classification map and phytoecological zones of the vegetation landscapes.

Tree biometric measurements were conducted in the Bontioli nature reserve, in southwestern Burkina Faso with systematic sampling based on quadrats (plots) of 30 m by 30 m on regular intervals of 1 km. Within each quadrat, parameters measured were individual tree position, tree height, DBH (Diameter at Breast Height), crown cover/depth and species scientific name. Similarly, information on soil type and land type were collected and compiled in a GIS database. The ecological modelling of spatial tree patterns was based on Poisson and Negative binomial distribution models. Tree species diversity estimates were computed according to Shannon-Wiener and Simpson indexes; species richness was estimated by Jackknife and Rarefaction models. Relationships between tree species, vegetation, soil and land types were analysed through contingency coefficients. Test of non-similarity of savannah types were done by ordination methods. The supervised classification was done using Landsat Enhanced Thematic Mapper Plus scene (ETM+ scene) 196/52 of October 2002, pixel size of 28.5 m. Validation was done by ground truthing and the final map was designed using the soil map of the region to adjust and validate the phytoecological zones.

The final results revealed that the nature reserve provides a habitat for $70.9 (\pm 1.9)$ tree species spatially aggregated but randomly distributed within each clump. The tree community was organised according to three main vegetation types such as tree, shrub savannahs and gallery forest detailed in an accurate classification map (i.e. overall accuracy = 98.8 %) which was used as basis for the phytoecological zones map. The second map summarises relationships between savannah physionomy, phytosociology, soil and land types.

Keywords: Biodiversity, ecological modelling, phytoecological zone, remote sensing GIS, semi-arid land, Volta Basin, vegetation classification, West Africa

Study on Hainan Provincial Environmental and Resource CGE Model

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The lack of natural resource and the degradation of ecological environment caused by the rapid global economic growth after 1960's, are a major challenge to human beings. There is a realization now that social development should be based on sustainable use of natural resources. This paper discusses how to build an 'Environmental and Resource Computable General Equilibrium' (ERCGE) model with CGE theory and establish a 'Hainan provincial Environmental and Resource Social Accounting Matrix (ERSAM)'. Further, it simulates and quantitatively analyses economy-wide impacts of several presumed environmental policies on Hainan.

The paper is divided into three main parts:

The first part, presents the integration of environment and natural resources into the CGE model, and forms the basic structure and equations of the ERCGE model. Based on Chinese economic CGE model and Hainan provincial CGE model built before, it extends and develops an ERCGE model that includes natural resources and environment. The primary approach is to incorporate natural resources as production factors and environmental cost as production cost into this model.

The second part focuses on the establishment of a Hainan provincial ERSAM and parameter calibration of the ERCGE model. The paper estimates Hainan natural resource value and environmental control cost using Hainan provincial data and methods of accounting environment and natural resource values. It then 'integrates natural resource value' as a contributing factor and 'environmental cost' as a separate account into ERSAM. Finally, it calibrates ERCGE parameters on the basis of ERSAM.

The third part describes environmental policy simulation. It analyses potential impacts and effects of changes of natural resource price and environmental cost, on Hainan macroeconomy, productive sectors, usage of natural resources and environmental protection. This provides scientific reference for environment and natural resource decision-making, and benefits sustainable economic development in Hainan.

Keywords: ERCGE Model, ERSAM, accounting environment, resource value, Hainan, policy simulation

Integrated Crop-Livestock Bioeconomic Modelling Approach for Assessing the Impact of Productivity Enhancement Technological Interventions on Economic Performance, Soil Erosion and Nutrient Flow at Micro Watershed Level

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The erratic rainfall pattern and degraded natural resources coupled with poor policies cause poverty and hunger in the semi-arid tropics of India. The watershed development programme approach aims to improve land use and sustainability as well as improving the livelihood security of the households in the rainfed areas. To realise the potential of the micro watershed projects in enhancing the livelihood security of the poor in the rainfed areas, investment in India in the mid- 1990's by the Indian government and international organisations in collaboration with the NGOs and other development agencies, amounted to about USD 500 million per year. Even though there are several exceptional case studies of successful watershed development in India, the impact of the approach on improving the welfare of the poor and the natural resource condition in the SAT areas is not fully known. This study applied a holistic and integrated approach, like bio-economic modelling, by incorporating both economic and biophysical aspects to simultaneously assess and evaluate the impact of productivity enhancement technologies (like improved high yielding varieties, cereal-legume intercropping and *in situ* soil and water conservation technologies) on the welfare of the poor and the natural resource conditions of Adarsha watershed in Kothapally village, Andhra Pradesh, India. The model predicted that the adoption of high yielding varieties of dryland crops leads to an increasing area under sorghum/pigeonpea and maize/pigeonpea cereal-legume intercropping systems and reduced the area under cotton resulting in higher income for farmers. The increase in yield of dryland crops has a positive effect on incentives to conserve land resulting in less soil erosion and nutrient mining in the watershed. Moreover, the increase in fodder availability enhanced the income of the farmers through increased livestock rearing.

Keywords: Bioeconomic model, erratic rainfall, productivity enhancement technology, watershed development programme

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Spatial explicit modelling of land use change

Oral Presentations	385
MARCUS KAPLAN, QUANG BAO LE, FABRICE RENAUD: Land Use Changes, Mangrove Destruction, and Vulnerability in Maduganga Lagoon, Sri Lanka - Empirical Analyses Towards Agent-Based Modelling	385
CARSTEN MAROHN, ANDREAS DISTEL, JUAN CARLOS LASO BAYAS, DIAN YUSVITA INTARINI, GERD DERCON, SONYA DEWI, BETHA LUSIANA, UWE MEYER, LAXMAN JOSHI, MEINE VAN NOORDWIJK, GEORG CADISCH: Assessing Short and Long Term Time Dimensions of the Tsunami Impact on the Green Infrastructure in Aceh, Indonesia: A Challenge to Data Collection and Methodological Approaches	386
KRISHNA BAHADUR K. C.: Modelling and Measuring the Economic Success of Farming Families Using Remote Sensing and GIS: A Case from Mountains of Nepal	387
JÖRG A. PRIESS, MATTHIAS MIMLER, HEIKO FAUST, STEFAN SCHWARZE, ALEXANDER OLTSCHEV, ALEXANDRA-MARIA KLEIN, STEFAN ERASMI: Land Use Dynamics and their Socio-Environmental Impacts: Results from Simulation Studies with the Site Modelling Framework	388
Posters	389
DIAN YUSVITA INTARINI, CARSTEN MAROHN, GERD DERCON, DESI SUYAMTO, BETHA LUSIANA, LAXMAN JOSHI, MEINE VAN NOORDWIJK, GEORG CADISCH: Modelling Farmer's Land Use Decisions after the 2004 Tsunami Event: A Case Study in West Aceh, Sumatra, with Respect to Annual and Tree-Crops-Based Systems	389
NDOH MBUE INNOCENT, JIWEN GE: Impervious Surface Analysis of Terrestrial Watersheds: Implication for Sustainable Land Use and Land Management Practices in the Puding Area of Guizhou Province, China	390

- MOHAMMAD JAFARI, MOHAMMAD TAHMOURES, HAMID REZA NASERI:
GIS Based Ecological Planning and Sustainable Development Model for the Sefidrood Basin, Iran 391
- HASAN AHMADI, ADEL KELARESTAGHI, MOHAMMAD JAFARI, MOHAMMAD TAHMOURES:
Land Use Changes Detection and Spatial Distribution Using Digital and Satellite Data, Case Study: Farim Basin, Iran 392
- FOTSO LUCIEN, MARTIN KAPPAS, PAVEL PROPASTIN:
Remote Sensing Based Study on Land Use / Land Cover Change in a High Populated Region in Bamileke Highlands, Cameroon 393
- KATJA BRINKMANN, UTA DICKHOEFER, EVA SCHLECHT, ANDREAS BUERKERT:
Integrated Assessment and Land Use Scenarios for a Sustainable Development of Al Jabal al Akhdar Oases in Northern Oman 394
- HARUN TANRIVERMIS, GÖNENC SERTAC, MEHMET BÜLBÜL:
Land Use Change Analysis and Sustainable Use of Land Resources in Turkey 395
-

Land Use Changes, Mangrove Destruction, and Vulnerability in Maduganga Lagoon, Sri Lanka - Empirical Analyses Towards Agent-Based Modelling

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The study investigates land use and land cover changes (LUCC) in Maduganga Lagoon on the southwestern coast of Sri Lanka. LUCC are caused by a set of interacting driving forces, which are formed by a complex of biophysical, socio-economic, political, technological, and cultural variables. Therefore, understanding of historical LUCC as well as the simulation of future developments calls for integrated approaches. Agent-Based Models (ABMs) have been recognised as an appropriate means for integrated landuse analysis, since they provide a natural presentation of the human-environment systems and capture related biocomplexities. However, building credible ABMs to inform land management requires empirical analyses of agent behaviour as well as rigorous characterisation of historical landuse dynamics.

Prior to the application of an ABM for depicting integrated scenarios of LUCC, we conducted intensive field surveys and empirical analyses to characterise household behaviour and historical LUCC. Interviews with 538 households living around the lagoon were done using a structured questionnaire that captures the five asset categories of the Sustainable Livelihoods framework. Plots of all interviewed households were visited to gather spatially explicit landuse practices and outputs. Multivariate statistics was used to define and characterise the different household livelihood typologies, and socio-ecological determinants of their landuse choices. In addition to the agent parameterisation for the ABM, the analyses also show empirical effects of environmental degradation and the destruction of mangroves on the livelihood of the people and their vulnerability to different types of hazards, particularly considering the tsunami in 2004.

Historical LUCC are analysed using aerial photographs and Landsat ETM+ imagery. The spatial analysis detected increases in agricultural lands and urban structures during the last 50 years at the expense of mangroves and other forest ecosystems.

Since our empirical analyses are household- and spatially-explicit, we will use the data and analytical results for agent-based simulations of LUCC and associated socio-economic dynamics. These simulations will be derived from different scenarios of coastal landuse planning and forest protection. An existing ABM developed at the Center for Development Research (ZEF) will be modified in order to be applicable to our study area.

Keywords: Agent-based modelling, land use modelling, mangrove, Sri Lanka, tsunami, vulnerability

Assessing Short and Long Term Time Dimensions of the Tsunami Impact on the Green Infrastructure in Aceh, Indonesia: A Challenge to Data Collection and Methodological Approaches

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The earthquake and Tsunami of December 26, 2004, had far-reaching effects on all sectors of coastal Aceh Barat, Indonesia, the district closest to the epicentre. While direct effects on human population shortly after the event received adequate attention by relief organisations, various trends in land use change and its impact on livelihoods were not addressed. With a focus on the green infrastructure, this research aims at linking up short- to long-term impact of the Tsunami on tree crop damage and land use change. A combination of biophysical and socio-economic parameters covering appropriate time horizons has been selected to unveil underlying patterns. Under the aspect of losses of lives as well as physical damage to infrastructure and trees immediately after the event, the role of existing tree belts in coastal protection is assessed using and combining tools such as high resolution satellite images, GIS-based land use classification and statistical data at sub-village level. To determine short- to mid-term effects of soil subsidence, salinisation and mud deposits by the Tsunami on crops and trees, repeated biophysical measurements were conducted, which were consolidated through farmer interviews and field observations to quantify tree damage.

Farmers' perception of the mentioned biophysical factors and the largely changed socio-economic settings influence land use decision making on household level in a longer perspective. Major factors playing an important role in the decision-making are development of markets and prices, the role of extension through development organisations and farmers' adoption and learning style. Present changes are monitored and an understanding for farmers' motives is developed using individual and focus group interviews. These data serve as input for a modelling approach to prospect a baseline as well as alternative land use scenarios over a time horizon of 30 years.

The recent opening after decades of social unrest and isolation, massive external influence and interests and cultural peculiarity make Aceh a unique case to observe changes on different time-scales. The challenge of selection, combination and triangulation of data in an extremely dynamic environment will be highlighted in the presentation.

Keywords: Aceh, biophysical impact, Indonesia, land use change, temporal dynamics, tree crops, tsunami

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Modelling and Measuring the Economic Success of Farming Families Using Remote Sensing and GIS: A Case from Mountains of Nepal

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Development of socio-economic condition in many mountainous areas of Asia mostly influenced by their spatial position. Socio-economic differentiation across the spatial gradient is due to the differentiation of resource availabilities, management, availability and the condition of infrastructure. The co-existence between biophysical and socio-economic condition raised the question whether a relationship between these two sectors and which factors determine the future development. This paper presents the methodology to model the economic success of farming-families and measures the impact of development strategies on economic success using spatial models.

Socio-economic conditions were assessed based on a survey with in-depth interviews with randomly sampled families. Biophysical and infrastructure data and satellite images were analysed in image processing and GIS. Road infrastructures were analysed using cost weighted distance model and land quality indexes were prepared. Socio-economic data were integrated in GIS by means of interpolation. GIS based regressions were constructed to establish the functional relation between economical and biophysical variable. Model results were compared with the survey results and based on the relation impact of assumed improving and worsening environment to the economic success were tested and presented.

Model shows economic success of farming families (farm family income) can be estimated through the biophysical variables (cost distance to market, land quality indexes and land productivity. Improvement of land quality through soil conservation shows the promising results in the currently low-income areas. Similarly, development and improvement of the road network, water management and combined strategies show their impact will be highest in the remote areas that are currently least accessible, low income. Water management strategies show an increment of annual income by 71–95 % to those of upland agricultural areas, which has currently no irrigation. Combined strategy of water management and road network shows an increment of income by 90–160 % for the low-income areas. Soil degradation scenario shows income loss would be higher around currently low-income areas in future, if current situation continue. In conclusion, if the tested strategies will be implemented an improvement of economic conditions, in the currently disadvantaged areas with low levels of natural resource endowment and economic success, could be achieved.

Keywords: Farm family income, GIS, Nepal, remote sensing, spatial differentiation, spatial modelling

Land Use Dynamics and their Socio-Environmental Impacts: Results from Simulation Studies with the Site Modelling Framework

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Land use and land cover change, especially in tropical regions, have received much attention in recent years. Land use dynamics are usually caused by a combination of large scale drivers of change such as global markets or climate, but also region-specific forces like demographic change and regional/local policies. During recent years we developed SITE, an integrated land use model, as a tool to study both socio-economic and environmental impacts of land use and land cover change, as well as the feedbacks of altered environmental conditions on future land use decisions. In the case study from Indonesia presented here, large areas of forest were replaced by cocoa agroforestry plots during the last two to three decades. These processes are intimately linked with agricultural intensification and ongoing population growth and rural immigration. Simultaneously, the food crop paddy rice, but also coffee agroforestry were losing importance in the regional agricultural production systems. In this paper we used the SITE model to study the dynamics of major land use and land cover types and quantify selected indicators of change. Focusing on the socio-environmental impacts of the agricultural transition process, we analysed environmental impacts in terms of (i) forest conversion e.g. to open secondary forest, agroforestry plots etc as well as (ii) the impact on profit margins of different crops. Additionally, we developed a policy scenario to study the potential impacts of rural immigration. Our simulation results revealed that — as expected - in the ‘no immigration’ scenario forest conversion was reduced. However, the average household income in the ‘no immigration’ scenario was reduced as well, due to the fact that the gross margins for traditional food crops grown by local farmers were lower than the ones for cocoa, a crop mainly introduced and grown by immigrants. While the rural population, living mostly close to or below the poverty line, obviously profited from the recent regional ‘cocoa boom’, the negative impacts of the ongoing threat of natural resources have not yet been quantified.

Keywords: Cash crop, Indonesia, land use modelling, socio-environmental systems, subsistence crop, Sulawesi, tropical agriculture, tropical rainforest

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Modelling Farmer's Land Use Decisions after the 2004 Tsunami Event: A Case Study in West Aceh, Sumatra, with Respect to Annual and Tree-Crops-Based Systems

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The coastal zone of West Aceh was the most affected area by the Indian Ocean earthquake and the following Tsunami in 2004. Not only thousands of people were killed and infrastructure swept away, but the event also led to drastic changes in land use along the coastal area, due to subsidence, ground water salinisation and changed soil properties by mud deposits. In response to these biophysical and infrastructure changes, farmers as main agents in the agricultural sector faced important challenges in making decisions to select the right livelihood options to fulfil their needs. Furthermore, Post-Tsunami socio-economic changes as consequence of disaster relief and reconstruction of infrastructure influenced farmers' decision making to allocate their time either for agricultural or off-farm activities.

The aim of the present study was to understand farmers' land use-related decision making after the Tsunami and the principal driving factors influencing these decisions. Four objectives have been included in the study: **(i)** to identify land use dynamics from before the Tsunami event until present, **(ii)** to understand biophysical and socio-economic factors determining farmer's decision making on annual and tree crop based land use systems, **(iii)** to prospect a baseline land use sequence in the next three decades using a simulation model, and **(iv)** to explore alternatives future land use trajectories through scenario studies using a simulation model.

Collecting socio-economic and biophysical data related to farmer's decision making is the first methodological step. Data gathering is carried out through in-depth interviews at household level. Selecting households, purposive random sampling is applied along existing transects used by two associated subprojects. Interview data will serve as baseline for these studies but are mainly intended for parameterisation of a modified Adopt & Learn Model.

The expected results from the study are a better understanding of land use before and after the Tsunami, and biophysical and socio-economic drivers of farmers' land use decision-making in the study area, a prospect of the land use dynamics based on farmers' adoption strategies and finally, a simulation of alternative future land use trajectories.

Keywords: Decision-making, Indonesia, land use, modelling, tsunami

Impervious Surface Analysis of Terrestrial Watersheds: Implication for Sustainable Land Use and Land Management Practices in the Puding Area of Guizhou Province, China

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Increasing population, roads, commercial and industrial development are gradually replacing natural terrestrial environments such as grasslands and forests in most parts of China. One of the principal effects of development and urbanisation is the conversion of pervious surfaces into impervious surfaces. Research over the past decades has indicated that increased quantities of impervious surfaces are closely associated with environmental degradation, with the amount of impervious surfaces in a watershed being inversely correlated with the health of that watershed. Regularly classifying and quantifying land cover within a watershed, particularly the amount of impervious surfaces, is, therefore, important in monitoring the health of the watershed. Hence the main goal of this proposed study is to execute a change analysis of impervious surfaces using historical and current remote sensing imagery and classification mapping, and to document a protocol for monitoring changes of impervious surfaces, based on the terrestrial watershed draining to enable land managers to assess landuse changes and focus on areas for protection and/or restoration. Landscape-specific infiltration coefficients, classification mapping and change analysis software such as the Impervious Surface Analysis Tool (ISAT), will allow for an in-depth analysis of impacts. Landsat MSS scenes, one for the years 1995 and the other for the year 2002, historical baseline data collection, current data collection, and ground-truthing will be valuable sources of the database for this study. Landsat-based processing and classification should provide critically important, consistent and multi-date data for any area of Puding. It is envisioned that this data and updates, will contribute significantly to improved monitoring programs and management decisions that will lead to more sustainable land-use and land management practices in the area.

Keywords: Impervious surface, infiltration coefficient, land cover, landsat, puding area, remote sensing, watershed

GIS Based Ecological Planning and Sustainable Development Model for the Sefidrood Basin, Iran

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Ecological Planning is a process that evaluates the alternative land uses in relation to its environmental and socioeconomic surroundings, with the purpose of manage the natural resources, preserve the ecosystems and solve or diminish possible environmental conflicts. The objective of this work was to generate an ecological planning and sustainable development model by using GIS tools for the Sefidrood basin. The goals of sustainable development in developing countries are not being met, partly because of a lack of access to advanced technology for environmental monitoring and for development of sound and sustainable land management practices. Geographic Information Systems (GIS) are unique and important tools for monitoring the degradation of ecosystems. These tools can help to define priority areas for conservation and development, and can also be used to accurately and efficiently verify the effectiveness of land use planning. Additionally, GIS can play an important role in monitoring natural resources depreciation and loss of essential services provided to mankind by ecosystems.

The project involved four stages: characterisation, diagnosis, forecast and proposals. In the first step both natural and socioeconomic aspects are described and delineated; in the diagnosis stage, the actual conditions are identified and evaluated, the third stage, forecast show the more likely trends in natural resources conditions if the actual use is maintained; finally; in the proposal stage we conformed the existing state of land use map and Land use Plan map and determine the amount of conformity of these two maps and then land capability is defined based upon the diagnostic stage. Implementation of this model will allow the rational use of the natural resources of the area, keeping in mind its conservation, and its capacity to provide ecological services to both the human and wildlife inhabitants of the area.

Keywords: Ecological planning, GIS, land use modelling, sefidrood basin, sustainable development

Land Use Changes Detection and Spatial Distribution Using Digital and Satellite Data, Case Study: Farim Basin, Iran

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Land use change may influence many natural phenomena and ecological processes, including runoff, soil erosion and sedimentation and soil conditions. Decrease of the forest area in the North of Iran is one of the critical problems in recent years. The aims of this study were to detect land use changes between: 1967 and 2002, using satellite images of Land Sat 7 ETM+ (2002), aerial photos and digital topographic maps (1967 and 1994) and to investigate the effect of some physical and socio economical factors on land use dynamic. The forest maps of 1967 and 1994 were collected from 1:25000 digital maps in Micro Station and then transferred to Arc View 3.2 software. The interpretation of the maps of other land uses was derived using aerial photos. ETM+ Satellite data were used to generate land use maps for 2002. The images quality assessment and georeferencing were performed on images. Different suitable spectral transformations such as rationing, PCA, Tasseled Cap transformation and data fusion were performed on the images in ENVI and IDRISI software. Image classification was done using supervised classification maximum likelihood and minimum distance classifier utilising original and synthetic bands resulted from diverse spectral transformation and the forest area was separated from non forest area. Unsupervised classification was used to separate other types of land use. Change detection has shown that the forest area decreased between 1967 and 2002 by 21 % from 7322 to 6947 ha. Also, the area with irrigated land farms have been increased to 202.01 ha (+1.6 %) and the dry land farming area decreased to 9.2 %. Overlaying the map of land use change with roads and residential maps showed that by increasing the distance from roads and residential areas and villages, deforestation rate and conversion of forest to arable lands were reduced, but conversion of arable lands to released lands increased. Also, the most quantity of deforestation was observed in lower slope angle, but the dry land farming converted to release lands was observed in higher slope angle.

Keywords: Change detection, Farim Basin, Iran, land use map, spectral transformation

Remote Sensing Based Study on Land Use / Land Cover Change in a High Populated Region in Bamileke Highlands, Cameroon

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The study investigated the land use/land cover change (LULCC) and its driving forces in the Bamileke highlands in West Cameroon in Central Africa using a remotely sensed derived dataset, expert knowledge, official statistics and data collected in the field. The aim of the study was to detect LULCC over the period of 1959–2001 and analyse the link between LULCC and socio-economical conditions such as population growth, population distribution, and cultural behaviour of the population. The analysis based on interpretation of the informations derived from population census statistics, analogue topographic and morphologic maps and Landsat imagery. On one hand, in order to retrace the LULCC from the years 1959 to 2001, we visually interpreted two topographic maps from 1959 and 1961 as well as a Landsat MSS image from 1978. On the other hand, we carried out an automatical classification of multi-spectral Landsat images from the years 1988 and 2001. We tested different techniques of classification and obtained the best results by application of Maximum Likelihood algorithm to informations extracted from Principal Components of Landsat channels. The results revealed a clear change in the land use/land cover over the study period. The direction of the change and its magnitude vary between different land cover types. The highest change magnitude is associated with forest area. It decreased by 8.3 % alone during the period 1988–2001, the decrease of this land cover class during the whole period of 50 years was so enormous that at many localities a fully disappearance of large forest areas was proofed. The rapid decrease of forested area is caused by deforestation in advantage to the cultivated land and settlements. The areas enlargement of these both land cover classes was driven by a rapid population growth and the change of the cultural behaviour of the population in the study region. The results of the study provides a better understanding about the nature of the LULCC in the rain forest belt in Africa and exposes its environmental and anthropogenic driving forces.

Keywords: Cameroon, deforestation, LULCC, remote sensing

Integrated Assessment and Land Use Scenarios for a Sustainable Development of Al Jabal al Akhdar Oases in Northern Oman

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Since the beginning of the political opening and commercial oil exploitation in the early 1970s rapid social, and economic changes took place in Oman. These changes affect the development of the traditional cultural landscapes, particularly in the mountain areas, whereby the rural subsistence production lost its relevance and the agricultural land use declines. These transformation processes are described and modelled with a scenario analysis to determine strategies and methods for a sustainable development of mountain oasis systems.

The study is carried out at three selected villages in the central Al Jabal al Akhdar mountain range where disciplinary studies investigate the agricultural use, the physical and biological characteristics, the economy of selected households and the regional socio-economic impacts. Within a Geographical Information System spatial data (terrain, land use, vegetation) are combined with non-spatial socio-economic data (working activities, products, produced values) to evaluate the actual land use system.

These evaluation results are used as indicators and descriptors together with additional aggregated data for the creation of a spatially explicit landscape model. This model describes the functioning of the system and is used to create future landscape scenarios under varying economic and political conditions and constraints.

The methodical approach is based on a combination of various statistical models: the Field module calculates the horizontal and vertical nutrient fluxes; non-spatial social and economic aspects of crop and livestock agriculture are analysed within the Household module; the Landscape module focused on the linkage between economic and ecological variables, the calculation of sustainable indicators, the assessment of the suitability of site to agriculture use and the allocation of land use changes.

Keywords: Land use strategies, landscape model, scenario analysis, sustainable indicators

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Land Use Change Analysis and Sustainable Use of Land Resources in Turkey

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Intense utilisation of farm chemicals, mechanisation, as well as improved seeds and improved animal breeds in production as a result of the industrial revolution and green revolution since the 1950s has totally changed the structure of agricultural production. In parallel with the technological improvements, meadows and pastures, forest lands, and common property have also been open to agriculture via cultivating and this process has been supported, indirectly, through agricultural policy tools such as input subsidies and support prices. As a result of intensive use of chemicals and uncontrolled expansion of farmland, caused various environmental problems and these problems have negative impacts on human health.

However, land that is cultivable and can be made available for agricultural production reached their final limits in the 1970s. The main objective in increasing agricultural production has been boosting productivity per unit area and animal since then. The intensive agriculture has accelerated in land erosion, and a drop in the quality of non-renewable resources as well as a rapid degradation. In addition to the changes observed throughout time in land utilisation forms in agriculture, in the 1950–2005 period, the most productive farmlands that should be protected, were used for urbanisation, industrialisation, infrastructure, and tourism investments and it has not been possible to cease this process despite the legal arrangements.

In this paper, changes in land use, and factors affecting these (such as intensifying in agricultural production, population increase/urbanisation rate, increases in incomes, transportation, and incentive policies) are analysed using the 1950–2005 period data. The main factors affecting land use are analysed more detailed through mathematical models and the opportunities of sustainable utilisation of land resources are evaluated. Regional variations in land utilisation (such as utilisation for agriculture, forestry, meadows and pastures, and with other purposes) are analysed both in an overall sense and using mathematical models. Regulations for conservation of productive land for farming and opportunities to ensure meeting the food demands of the rapidly increasing population and prospects to control and monitor the changes in the current land utilisation forms are also briefly discussed.

Keywords: Land use change, Turkey, mathematical models

Soil fertility and management of organic matter

Oral Presentations	399
NHAMO NHAMO, CHRISTOPHER MARTIUS, PATRICK C. WALL, CHRISTIAN THIERFELDER: The Fate of Surface Residue Mulch During Dry Winter and Spring Seasons on Conservation Agriculture Plots in Zimbabwe	399
WANWISA PANSAK, THOMAS HILGER, GERD DERCON, THANUCHAI KONGKAEW, GEORG CADISCH: Mineralisation and Leaching of Nitrogen as Affected by Contour Hedgerow Systems on Moderate Slopes in Northeast Thailand	400
GENTIANE BLANCHARD ORTIZ, ANNE CHABOUSSOU, SYLVIE SPOERRY, MIREILLE DOSSO: An Integrative Approach of the Geography of Soil Organic Matter (SOM) Management Practices to Prospect Future Below-Ground BioDiversity Erosion (BGBD), in the Taita Hills, South-East Kenya	401
JENS GEBAUER, EIKE LUEDELING, KARL HAMMER, MAHER NAGIEB, ANDREAS BUERKERT: Agrobiodiversity in Mountain Oases of Northern Oman	402
Posters	403
OPEYEMI ANTHONY AMUSAN, PHILIP OGUNTUNDE, OLU-SOLA ADUKE AMUSAN: New Relationship Between Crop Yield and Soil in the Cocoa Belt of Nigeria	403
ELIAS GICHANGI, PEARSON MNKENI, PHIL BROOKES: Changes in Inorganic and Microbial P Fractions Over Time Following Goat Manure and Inorganic Phosphate Addition to a High P Fixing Soil	404
KINDOMIHOU VALENTIN, AMBOUTA KARIMOU JEAN MARIE, SINSIN BRICE: Diversity of Soil Fertility Management Practices in the Sudanian Zone of Benin (Western Africa)	405

HOSSEIN SABAHI, HOUMAN LIAGHATI: Study on Effects of Integrated and Conventional Fertilisation Systems on Chemical Properties of Soil and Rapeseed (<i>Brassica napus</i>) Yield	406
MINGRELIA ESPAÑA, THOMAS BRUNE, ELLEN KANDELER, GEORG CADISCH: Effect of Plant Residue Quality on Soil Fungal Community in a Vertisol	407
MICHAEL DARE, OLAJIRE FAGBOLA, ROBERT ASIEDU: Heritability Estimates of Arbuscular Mycorrhizal Colonisation in <i>Dioscorea</i> Species in Yam Growing Regions of Nigeria	408
REZA MIRZAEI TALARPOSHTI, JAFAR KAMBOUZIA: Influence of Organic and Chemical Fertilisers on Growth and Yield of Tomato (<i>Lycopersicon esculentum</i> L.) and Soil Chemical Properties	409
ADRIANA CAMPOS, HOLM TIESSEN, BARBARA WICK: Seasonal Effect on Enzyme Activities in Calcareous Soils from the Yucatan Peninsula, Mexico	410
KHALID SAIFULLAH KHAN, RAINER GEORG JOERGENSEN: Microbial C, N, and P Relationships in Moisture Stressed Soils of Potohar, Pakistan	411
KARINA PEÑA PEÑA, VIOLETTE GEISSEN: Effects of Land Use Change on Soil Chemical and Biological Properties in Teapa, Tabasco (SE-Mexico)	412
BEATE FORMOWITZ, RAINER GEORG JOERGENSEN, ANDREAS BUERKERT: Separating Soil Chemical and Biological Effects of Legume Rotation-Induced Cereal Growth Increases on West African Soils	413
LALITA SIRIWATTANANON, MACHITO MIHARA: Effects of Rainfall Intensity on Soil and Nutrient Losses from Fertilised Upland Fields and Farmers' Acceptability in North-east Thailand	414

The Fate of Surface Residue Mulch During Dry Winter and Spring Seasons on Conservation Agriculture Plots in Zimbabwe

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Mulching is important in reducing erosion and increasing stability of poorly structured degraded soils. The high intensity short duration erosive rain storms experienced at the onset of the wet cropping season in Zimbabwe makes soil cover especially important. Maintaining soil cover under Conservation Agriculture (CA) systems also contributes to soil biota biomass build-up. Given competing uses of crop residues on the farm, knowledge of mulch losses through decomposition is important in maintaining and managing the minimum (30 % soil cover) requirements under CA. Decomposition of surface applied mulch over the winter and spring seasons which precede the wet summer, determine the amount of soil cover at the beginning of the rainy season. Coarse meshed polyester litter bags were used to study the rate of maize litter loss from the soil surface. The aim of the experiment was to assess the rate of fauna driven mulch decomposition on CA and conventional ploughing plots. A total of 256 litter bags, mesh size 5 mm, were used to measure mass loss during winter and spring from one on-station (Henderson), four on-farm sites (two each from Shamva and Zimuto). The sites represented agro-ecological zones II and IV of Zimbabwe and were found on heavy clayey and sandy soils. At Henderson litter bags were applied on the soil surface on conventional ploughing (CP), direct seeder (DS), basins (BA) and Magoé ripper (MR) treatments. On-farm conventional ploughing, sub-soiling (SS) and direct seeder treatments were used. A negative exponential decay model $y = y_0 e^{-kt}$ described surface litter losses data adequately. At Henderson, daily k rates were in the order $BA > DS = CP > MR$ whereas at Chinyanga and Kajengo (Shamva) and Zhinya (Zimuto) $DS > SS > CP$. The influence of soil mulch on the microclimate explained the variation in decomposition between CA treatments and conventional ploughing. The measurements suggest low decompositions rates of surface applied maize litter during winter and spring. Losses can be managed by mulch supplementation to achieve adequate soil cover at the start of the rainy season. Further, the results show that decomposition during winter allow carryover of mulch on CA plots into the next season.

Keywords: Decomposition, maize stover mulch, reduced tillage, soil health, organic matter use

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Mineralisation and Leaching of Nitrogen as Affected by Contour Hedgerow Systems on Moderate Slopes in Northeast Thailand

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Minimizing soil erosion by introducing contour hedgerow systems has been proposed by several development agencies. These systems have been widely tested in hillside cropping area of tropical mountainous regions over the last two decades. Apart from influences on crop performance, this alteration of the production system is associated with changes of the nitrogen availability, e.g. leaching and mineralisation. The objective of this research was, therefore, to assess the mineralisation and leaching of nitrogen in three contour hedgerows systems and their impact on the crop performance compared to a control without hedgerows. The field experiment was established as split plot design with two replicates in 2003 at Na Haew district (17°33' N and 101°1' E), northeast Thailand. The treatments were three contour hedgerow systems, vetiver grass (*Vetiveria zizanioides*) barriers and ruzi grass (*Brachiaria ruzizienses*) barriers, leucaena (*Leucaena leucocephala*) hedges and a control without hedgerows and two fertiliser levels (no fertiliser and 61 kg ha⁻¹ of N plus 14 kg ha⁻¹ of P). In all treatments maize (*Zea mays*) cv. Suwan 1 was planted, relay cropped with jack bean (*Canavalia ensiformis*) using minimum tillage. Plot size was 4 m by 18 m. Data on N mineralisation were recorded in 2004 and 2005. N mineralisation and leaching were measured by using the soil core and the resin core method. Resin cores were established at a depth of 90 cm. A significantly higher N mineralisation (0–75 cm) was observed in all fertilised treatments compared to those without fertilisation. The highest total N mineralisation without N fertiliser was found in the treatment with leucaena hedges. On average, it ranged from 133 kg ha⁻¹ in 2004 to 154 kg ha⁻¹ in 2005. The highest total N mineralisation was found in the leucaena hedges treatment with fertiliser application about 186 kg ha⁻¹ in 2005. The cumulative N leaching was slightly higher in contour hedgerows systems compared to the control without hedgerow (50 vs. 45 kg ha⁻¹ year and 36 vs. 32 kg ha⁻¹ year in 2004 and 2005, respectively). These findings indicate that improved nitrogen availability is counteracted by higher leaching losses despite the presence of hedgerows.

Keywords: Hedgerow systems, nitrogen leaching, nitrogen mineralisation, resin core method, tropical mountainous regions

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An Integrative Approach of the Geography of Soil Organic Matter (SOM) Management Practices to Prospect Future Below-Ground BioDiversity Erosion (BGBD), in the Taita Hills, South-East Kenya

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The issue of land intensification impacts on Below-Ground BioDiversity (BGBD) erosion is often addressed by linking soil micro-, meso- and macro-fauna quantity with land cover. However, it is also possible to adopt a deductive approach by drawing the geography and the dynamics of farming practices -- related to Soil Organic Matter (SOM) management -- with a direct bearing on BGBD. This integrative approach is based on an analysis of the socio-economics of land cover, e.g. determinants of farming practices. It helps building scenarii on future evolution of soil fertility.

This paper presents the outcomes of two fieldworks in the Taita Hills and their surrounding semi-arid plains, South-East Kenya. Small-scale farmers adopt various strategies to cope with increasing land scarcity. Some strategies are particularly outstanding, e.g. the intensification of the farming practices in the more humid highlands or the agrarian colonisation of the semi-arid foothills and lowlands.

This study required a multidisciplinary and systemic approach. Based on an extensive data collection on a 52 square km area, in-depth interviews and fool-proofing process, involving 150 farmers and key informants, eleven farming systems were identified. The farming systems segmentation relies on (i) combination of cash and home-consumption production (horticulture, dairy, coffee beans, maize, beans, and extensive livestock), (ii) farm acreage, (iii) livestock, (iv) labour force and (v) possible casual labour. It was hence possible to link the localisation of each farming system with the identified farm trajectories: highland valley bottom, rainfed highland and midland, foothills and lowlands. Furthermore, main SOM management practices were identified in each system, such as organic and inorganic fertiliser application, mulching, composting, fallow rotation, etc. Areas where SOM was decreasing and BGBD could be severely reduced were eventually located.

At a larger scale, the diversity of farming practices results in a mosaic of soil fertility status. The key drivers are pedoclimatics (natural resources distribution) and socio-economics (livelihood systems). Further consequences of BGBD erosion and fertility decrease are to be expected on land use and livelihood systems.

Keywords: Below-Ground BioDiversity (BGBD), farming practices, Kenya, land intensification, soil organic matter management, Taita Hills

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Agrobiodiversity in Mountain Oases of Northern Oman

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Little is known about agrobiodiversity in the complex mountain oasis systems of northern Oman. Therefore, a survey was conducted to assess the crop diversity of three mountain oases in the al-Hajar range using a GIS-based field survey and farmer interviews. While arid conditions prevail throughout the mountain range, the different elevations of Balad Seet (950–1020 m asl), Maqta (930–1180 m a.s.l.) and Al Jabal al Akhdar (1750–1930 m a.s.l.) provide markedly differing agro-climatic conditions. Overall, 107 different crop species were identified belonging to 39 families. Diversity was highest among fruits (33 spp.), followed by vegetables (24 spp.). However, the number of species varied significantly between sites. Fruit species diversity and homogeneity of distribution of individual fruit species was highest at Balad Seet and lowest at Maqta as indicated by respective Shannon indices of 1.00 and 0.39 and evenness values of 32 % and 16 %. Several relict crops were identified, supporting oral reports of past cultivation and providing evidence of genetic erosion. Some species, such as the temperate fruits of Al Jabal al Akhdar, were exclusively found at the coolest site, while others only occurred at the hotter locations. Overall greatest species similarity was found between Balad Seet and Al Jabal al Akhdar as indicated by a Sørensen coefficient of similarity of 67 %. At all oases a multilayered vegetation structure dominated with a canopy, an understory and a ground layer. Greatest species richness was recorded in the lowest stratum. Remote Omani oases are also an important refuge for indigenous wild plant species, such as *Epipactis veratrifolia* Boiss. & Hohen. ex Boiss. Several individuals of this endangered orchid were found flowering in an isolated part of the oasis Maqta. The study shows a location-specific but surprisingly diverse mosaic of crops in Omani mountain oases. To document the agrobiodiversity of Oman, assessments in more of the numerous Omani mountain oases are needed. Furthermore, follow-up visits to Balad Seet, Maqta and Al Jabal al Akhdar will be critical to document the transformation processes in these oases and to determine the pace of genetic erosion.

Keywords: Agrobiodiversity, agroforestry systems, Arabian peninsula, Arabic ethnobotany, cultivated flora, multicropping systems

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New Relationship Between Crop Yield and Soil in the Cocoa Belt of Nigeria

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The wealth of a nation depends largely on its ability to properly harness of its natural resources, which include soil. The Southwestern region of Nigeria is the largest administrative region in Nigeria with an estimated population of about 40 millions. About 90 percent of the rural dwellers depend on farming for livelihood but a downward trend has been noticed in both cash and food crops production in the last few years. This constitutes a threat to food security and calls for efforts to explain the trend and make recommendations for improvement. Soil qualities of selected farmlands in the Southwestern Nigeria were studied to evaluate its quality and its impact on agriculture using the case of Cocoa.

Soil samples were collected from three locations having similar agro-ecological features, namely Ibadan, Ife and Akure. Soils were analysed for chemical analyses. The soils were analysed for basic cations (determined in NH_4OAc), total N (Kjedahl method), available P (Bray P method), organic C (Walkey-Black wet oxidation method) and pH (0.1 M CaCl_2). Biophysical data were also generated from the soil analyses.

Socio-economic analyses in combination of soil surveys were also adopted in the properties. Resource quality and constraints to agricultural production were covered in the socio-economic surveys while contribution of soil to crop yield was accessed through soil analyses. Information on factors affecting crop yield was elicited by interviewing farmers on their farms using standardised questionnaire. Linear multiple regressions were used to determine the relationships between crop yield and variables presumed to influence yield. Soil organic C, age of farm soil, and CEC were identified as the major constraints to yield. Other variables are related to biophysical and management factors.

It is recommended that emphasis should be placed on soil management techniques that conserve organic matter and enhance the nutrient and water holding capacity of the soils. Policies that would foster sustainability of agricultural land use and crop marketing are also required.

Keywords: Cocoa, food security, land use management, Linear Multiple Regressions, soil organic C

Changes in Inorganic and Microbial P Fractions Over Time Following Goat Manure and Inorganic Phosphate Addition to a High P Fixing Soil

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Phosphorus transformations in untreated and manure treated soils at varying inorganic P application rates were assessed in controlled laboratory incubation experiments using a sequential fractionation procedure. Phosphorus was added at rates of 0, 45, 90, 135 and 180 mg P kg⁻¹ as triple super phosphate with or without 20 t ha⁻¹ of goat manure (dry weight) and incubated moist for 12 weeks. Resin P, soil microbial biomass P, 0.5 M NaHCO₃ extractable inorganic P (NaHCO₃-Pi) and 0.1 M NaOH extractable inorganic P (NaOH-Pi) concentrations were determined on days 1, 7, 14, 28, 56 and 84. Addition of inorganic P increased all P fractions but the increases were greater when goat manure was co-applied. The control treatments had only 17.2 and 27.5 mg P kg⁻¹ of resin extractable P in the un-amended and manure amended treatments, respectively which increased to 118.2 and 122.7 mg P kg⁻¹ at the highest rate of P application (180 mg P kg⁻¹) on day 28 of incubation. NaOH-Pi was the largest extractable Pi fraction and ranged from 144 to 251 mg P kg⁻¹ and 108 to 213 mg P kg⁻¹ in the unamended and manure amended treatments, respectively. Inorganic P addition increased the microbial biomass P concentration from 17 to 44 mg P kg⁻¹ in P alone treatments but the fraction was greatly enhanced with manure addition, increasing it from 32.6 to 97.7 mg P kg⁻¹. The largest improvement in microbial biomass P due to manure occurred at low rates of added P indicating the potential of goat manure to enhance the fertiliser use efficiency of low doses of P fertilisers. This increase in microbial biomass P following goat manure addition implies that the presence of goat manure increased the proportion of added P immobilised in microbial cells that would be subsequently released into the soil solution and be available for plant uptake following microbial turnover.

Keywords: P fractionation, goat manure, microbial biomass, resin-P

Diversity of Soil Fertility Management Practices in the Sudanian Zone of Benin (Western Africa)

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The sudanian agrarian landscape of Benin highlighted various practices of soil fertility management. The present study raises some traditional practices such as agro forestry, fallow, animal parking, hiding of crop waste products, revenues of grazinglands post-harvests, farming associations and rotations, which were largely used by 67 % of smallholdings.

Specifically, the agroforestry parkland system in the sudanian agricultural territories showed five variant practices: (i) Woody parks with *Parkia biglobosa*, *Vitellaria paradoxa*, *Adansonia digitata* and *Ceiba pentadra*; (ii) Fields pioneers on forest territories; (iii) Agricultural plots planted with fruit-lofts of *Anacardium occidentale* and *Mangifera indica*; (iv) Shifting cultivation using *Eucalyptus camaldulensis*, *Acacia auriculiformis* and *Leucaena leucocephala*; (v) Planted fallow with *Tectona grandis* and *Gmelina arborea*. This traditional system is more largely used, as well as the planted fallows of fruit-lofts, collective fallows grazed under contracts, the fixed parking of sedentary herds that offer some sites which may undergo beneficial for the corn monoculture. The crop waste products and waste domestic are largely exploited by using balks. The revenues of grazing ground post-harvest, higher at leguminous plants control the flows of post-harvests residues, and develop the mechanism of guarantees of grazinglands. The cereal-leguminous plants account for 63 % of farming associations, and are noticed where the organic manure is slightly used. The essential farming successions are the cotton/cereals well marked of back-effects of mineral manures and the cereals/leguminous/cereals which produce a nitrogen profit.

The improved practices such as improved parks, composting, improving plants cropping (i.e. *Vigna unguiculata*, *Glycine max*, *Mucuna pruriens*, *Aschynomene histrix*, *Cajanus cajan* and *Moringa oleifera*) were woefully adopted. The biological cotton slightly scaled with an annual rate of implementation of 8 % and average output of 600 kg ha⁻¹; reducing investments, risks in animal and human health and enhancing agro forestry practice. The improved technical route was ruled with a relative implementation i.e. 25 % of farmers using thinning while 52 % used flat ploughing, 71 % mineral manure rightly amounted and 55 % using organic manure. Sudanian farming systems in northern Benin associate intensive technical routes for certain crops such as cotton which is much more extensive and food for subsistence farming essentially sorghum, groundnut.

Keywords: Benin, soil fertility, fertility management, sudanian zone

Study on Effects of Integrated and Conventional Fertilisation Systems on Chemical Properties of Soil and Rapeseed (*Brassica napus*) Yield

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In a two years experiment, at randomised completely block design, the effects of integrated and chemical fertilisation on some chemical characteristics of soil and rapeseed yield were studied in Savadkooh region. Treatments conclude 0, 50, 100, 150, 200 kg N ha⁻¹ urea (F0 to F4), 150 kg N ha⁻¹ urea + 50 kg N ha⁻¹ manure (MF1), 100 kg N ha⁻¹ urea + 50 kg N ha⁻¹ manure (MF2), 50 kg N ha⁻¹ urea + 100 kg N ha⁻¹ manure (MF3), 150 kg N ha⁻¹ manure (M). After the first year results showed that the highest yield obtained from the integrated system (35 % N organic + 100 % N inorganic). There was no difference between the seed yield of the integrated and chemical treatments. But in the second year, the integrated treatments seed yield was significantly higher than the chemical treatments. Manure application improved chemical properties of soil. For example, the 100 % organic fertiliser system (M), increased available phosphorus and exchangeable potassium in amount of 115 % and 26 % compared to 100 % inorganic fertiliser system (F3). In integrated (MF1, MF2, MF3) and chemical treatments (F3) organic carbon increased but this increasing was respectively 12 % and 35 % at chemical and integrated systems. Total nitrogen had similar trend and their correlation coefficient were significant ($R^2=0.93$). Soil pH was not affected by treatments but EC (Electrical Conductivity) increased in chemical and integrated fertilisation systems compared to control treatment. In attention to the results, integrated fertilisation system can be suggested as a suitable strategy to improve nutrients recycle in soil and sustainability of yield in oilseed rape

Keywords: Canola, integrated fertilisation system, manure, oil rapeseed

Effect of Plant Residue Quality on Soil Fungal Community in a Vertisol

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Fungi play a major role in C and N cycling of plant residues, because of their ability to degrade complex substrates. Slow growing saprotrophic fungi are able to degrade lignin using extracellular enzymes and thereby gaining access to protected cellulose and hemi-cellulose compounds. On the other hand, fast growing opportunistic fungi (sugar fungi) are stimulated by easy accessible carbon sources. To evaluate the effect of plant residue quality on soil fungal community, an incubation experiment was conducted with highly ¹⁵N-enriched (99 atom%) plant residues of different quality, i.e. maize (C:N= 32, lignin:N=2.2) and soybean (C:N= 15, lignin:N=1.1), incorporated (1 %) in a Vertisol soil, taken from a long-term field experiment carried out in Venezuela since 1997. The residues were incubated for 30 days (25°C) at 40 % WHC. A control without residue was also used. The ergosterol content was measured after 3, 7, 15 and 30 days. DNA was extracted and the active and passive fungal community composition is being analysed by using the ¹⁵N-DNA stable isotopic probing (SIP) and molecular (DGGE, cloning and sequencing) techniques. Residues additions stimulated soil fungal activities and the quality of residues influenced the microbial biomass. The fungal biomass was higher in the soybean treatment already at early stages of decomposition compared to the maize treatment. This seems to indicate that quality of residues affected the fungal community, i.e. in soybean it is probably composed mainly of sugar fungi and in maize probably dominated by slow growing lignocellulytic fungi. Further DNA analysis should help clarifying this difference. High correlation was found between fungal biomass and enzymes activities involved in C-cycling suggesting that fungi play a major role in the recycling of C and nutrients in the tropical soil.

Keywords: Ergosterol, fungal community, residue quality, vertisol

Heritability Estimates of Arbuscular Mycorrhizal Colonisation in *Dioscorea* Species in Yam Growing Regions of Nigeria

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Sustainable food crop production in sub-saharan Africa is being limited by scarce land resources. Tuber crops are very essential in meeting the daily calorie requirements of the population, which at present is growing at an annual rate that is more than that of food production. Nutrient deficiency in the soil can be ameliorated through the use of fertiliser and symbiotic microbes such as arbuscular mycorrhizal (AM). There is limited information on the mycorrhizal status of yam (*Dioscorea* species). Hence, this study was conducted to determine the AM colonisation status and the possible heritability in different yam growing regions of Nigeria. Multilocational trials were conducted in 2004 and 2005 using twenty-seven genotypes of *Dioscorea rotundata* (TDr) and twenty-eight genotypes of *D. alata* (TDa). Locations used were Ibadan, Abuja, Onne and Ubiaja using a randomised complete block design with three replicates in all locations. Parameters assessed include AM spore density, percentage AM colonisation. Data were transformed as appropriate and analysis of variance carried out. In addition, GGE biplot analysis was also carried out. Percentage AM colonisation of yam genotypes varied from 1 - 95.0. Genotype, location and genotype by location had significant ($p < 0.05$) effect on the AM colonisation of yam. Broad sense heritability estimates for AM colonisation of TDr and TDa were 0.54 and 0.87 respectively. Combined analysis of genotype by environment interaction for AM colonisation revealed that TDr96/01799 and TDa00/0024 were the most stable while TDr Kokumo, Amula, 97/00903 and TDa00/00064, 98/01183 and 85/00250 ranked best in each three megaenvironments for TDr and TDa respectively. Spore density was highest at Ubiaja and lowest at Ibadan. Therefore, yam genotypes vary in AM colonisation and are influenced by environments.

Keywords: Arbuscular mycorrhiza, *Dioscorea* species, heritability, multilocational trials, soil fertility, yam

Influence of Organic and Chemical Fertilisers on Growth and Yield of Tomato (*Lycopersicon esculentum* L.) and Soil Chemical Properties

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In order to study the effects of organic and chemical fertilisers on growth and yield of tomato (*Lycopersicon esculentum* L.) and soil chemical properties, a field experiment was conducted with completely randomised blocks design with three replicates in the 2006 growing season at the experimental research station of Shahid Beheshti University at Zirab, North of Iran. The treatments were vermicompost, solid waste compost, cattle manure and chicken manure as organic fertilisers, chemical fertiliser (NPK, 150-60-60) and non-fertilised control plots. Fertilisers had significant effects ($p < 0.05$) on stem height, number of leaves, branches and dry matter of tomato. Effect of fertiliser source on yield and yield attributes (number of flower plant⁻¹, number of fruits plant⁻¹, percentage of fruit set and average fruit weight) of tomato was significant ($p < 0.01$) too. Vermicompost and cattle manure led to the highest and lowest tomato yield among organic fertilisers, respectively. In most cases, vermicompost and NPK produced the best results. The highest and lowest fruit yield were obtained in NPK and vermicompost (8.7 ton ha⁻¹) and non-fertilised (3.2 ton ha⁻¹) plots, respectively. Between organic fertilisers in most cases, vermicompost and solid waste compost applied performed best. Soil chemical properties and microbial biomass were evaluated in this study. Results showed that the fertiliser source had significant effect ($p \leq 0.01$) on percentage of organic carbon, organic matter, total nitrogen, availability of P and K. Addition of organic fertiliser resulted in increased total organic C (TOC), total N and available P and K levels in the soil. Chemical fertiliser resulted in decreased TOC and basic cation contents, and lowering of soil pH. As a result, however, the yield was too low in some organic fertilisers in comparison with chemical fertiliser, but had positive effects on soil which resulted in modification of soil structure thereby increases the yield in the long term.

Keywords: Chemical fertiliser, Iran, organic manure, tomato

Seasonal Effect on Enzyme Activities in Calcareous Soils from the Yucatan Peninsula, Mexico

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Under tropical conditions, the temperature varies within a narrow range and the rainfall regulates soil processes and nutrients release. In most tropical semiarid regions, the water availability is episodic, with long droughts alternating with short periods of high precipitation. The Yucatan Peninsula located in the most eastern part of Mexico, presents a great diversity of soils. Previous study has shown problems related to nutrient availability under contrasting soil moisture conditions. Soil enzymes play an important role in catalysing reactions for the organic matter decomposition and nutrient cycling. Therefore, the aim was to study the activities of four enzymes involved in C (β -glucosidase), N (protease) and P (acid and alkaline phosphatase)-cycling. The study sites were located in the communities of Hocaba and Xmakuil, Yucatan. The sampling was done once during the dry season and once during the rainy season (December 2004 and September 2005). Three land use systems were studied: Milpa, Homegarden, and Forest. Two soil types were chosen: black soil (Lithosols) and red soils (Rendzinas). The soil samples were taken at 0–10 cm depth. Acid phosphatase activity significantly increased during the rainy season (16–70%). The high activity might indicate P-deficient conditions. In the rainy season the plants are normally in a growth period, require major concentration of nutrients, there is more demand of P and the acid phosphatase activity shoots up. Protease activity decreased during the dry season (15–46%) and slightly increased during the rainy season. Both β -glucosidase and alkaline phosphatase activity did not vary between the dry and the rainy seasons. Forest soils always had the highest activity of the enzymes studied, due possibly to high substrate concentration, which promotes the activities.

Keywords: Calcareous soils, enzyme activities, land use systems, seasonal effect, Mexico

Microbial C, N, and P Relationships in Moisture Stressed Soils of Potohar, Pakistan

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At present, information regarding the role of the microbial biomass as sink and source of plant nutrients in sub-tropical soils under rain-fed dry farming is generally lacking. This is particularly true for the moisture stressed soils of the Potohar plateau in Pakistan. In 11 typical soil series of this region, microbial biomass C, biomass N, and biomass P were analysed and related to their element-specific total storage compartment, i.e. soil organic C, total N and total P. The quotient microbial biomass C-to-soil organic C indicates the availability of organic substrates to soil microorganisms. Similarly, the quotients microbial biomass N-to-total N and microbial biomass P-to-total P indicate the availability of organic N and P components to soil microorganisms. Also the elemental ratios within the microbial biomass, i.e. the quotients microbial biomass C/N and microbial biomass C/P have been demonstrated to give valuable information on the availability of nutrients to soil microorganisms, especially on that of phosphorus. The effects of climatic conditions and soil physico-chemical properties on these relationships were highlighted with special respect to crop yield levels. Average contents of soil organic C, total N, and total P were 3.9, 0.32, and 0.61 mg g⁻¹ soil, respectively. Less than 1 % of total P was extractable with 0.5 M NaHCO₃. Mean contents of microbial biomass C, biomass N, and biomass P were 118.4, 12.0, and 3.9 μg g⁻¹ soil. Microbial biomass C, biomass N, biomass P, soil organic C and total N were all highly significantly interrelated. The mean crop yield level was closely connected with all soil organic matter and microbial biomass related properties, but showed also some influence by the amount of precipitation from September to June. Also the fraction of NaHCO₃ extractable P was closely related to soil organic matter, soil microbial biomass and crop yield level. This reveals the overwhelming importance of biological processes for P turnover in alkaline soils.

Keywords: Crop yield level, microbial biomass, precipitation, soil organic C, total N

Effects of Land Use Change on Soil Chemical and Biological Properties in Teapa, Tabasco (SE-Mexico)

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SE Mexico has suffered in the past 60 years severe land use changes, resulting in the nearly disappearance of tropical forests and the pollution of the environment due to the intensive application of agrochemicals. We studied the effect of land use change on soil chemical and physical properties, earthworm communities, and litter decomposition in three different ecosystems: (1) banana plantations, (2) agroforestry systems, and (3) succession forests, along the floodplain of the river Teapa, Tabasco. At each site earthworms were collected (after the TSBF Methodology) and soil was sampled for further chemical analyses to determinate texture, content of nutrients, interchangeable cations, and pH value. Additionally, a litter decomposition experiment was carried out (litter bag technique) using two different leaf-litters: *Bravaisia integerrima*, a dominant tree from the original lowland riparian forests and *Musa acuminata* (banana leaves).

Soil analyses showed a significant lower content of soil organic matter and total nitrogen in managed ecosystems in comparison to the forests. Furthermore, pH values were significantly lower in two of the managed ecosystems, reflecting the adverse effect of the intensive use of ammonia fertilisers. Soils in managed ecosystems presented also high content in potassium and phosphorus, due to fertilisation of banana plants. Moreover, high content of Mn and Zn were determined in the managed systems, as a result of the intensive use of fungicides.

The study of the earthworm communities revealed higher diversity, density, and biomass of earthworms in banana plantations and agroforestry systems. However, most of these species were exotic, whereas in the forests most of the species were native, showing that the land use change had a negative effect on the local biodiversity.

Litter decomposition was not directly affected by the land use, since the activity of the soil biota was mainly determined by the microclimate within the plots. Nevertheless, banana leaves decompose much slower than the leaves from *B. integerrima*, due to content of lignin and higher C/N ratio retarding the reintegration of nutrients into the soil.

We concluded that the intensive management practice of the banana plantations in the study area did not affect soil fertility negatively.

Keywords: Earthworms, land use, litter decomposition, soil chemical properties, Mexico

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Separating Soil Chemical and Biological Effects of Legume Rotation-Induced Cereal Growth Increases on West African Soils

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Numerous reports have shown legume-rotation induced increases in cereals on nutrient-poor West African soils, however, their mechanisms are still debated. In this study differences in P and mineral N concentrations between continuous cereal (CC) and legume rotation (R) soils from the two West African sites Fada (Burkina Faso, F) and Koukombo (Togo, K) were determined and taken as the basis for nutrient application rates for a growth chamber experiment. Sorghum (*Sorghum bicolor* Moench) was planted on Fada soils and maize (*Zea mays* L.) on Koukombo soils. Treatments for CC soils consisted of five times the difference of N (N5), five times the difference of P (P5), and five times the difference of both nutrients (N5P5). Treatments for rotation soils consisted of four times the difference of the respective nutrient concentrations (N4, P4 and N4P4). These treatments were compared to the unamended soils (CC and R). Shoot length was measured daily. After harvest shoots and roots were analysed for their nutrient concentrations and total root length and mycorrhizal infection determined.

The combined application of P and N increased plant height significantly (FCC-P5N5 = 65 cm; FR-P4N4 = 59 cm; both FCC-P5 and FR-P4 = 55 cm) compared to N application only and to the unamended soil (FCC-N5 = 35 cm; FR-N4 = 40 cm; F-CC = 42 cm; F-R = 41 cm). Irrespective of the N and P level applied, for the same nutrient input shoot dry matter was significantly higher on rotation soils than on continuous soils (FR-P4N4 = 7.4 g; FCC-P5N5 = 4.7 g). Sorghum shoots had higher concentrations of P, K and Na for all CC treatments compared to the respective rotation treatments. In contrast, shoot N concentrations were significantly higher for FR-N4 (18.5 mg g⁻¹) and FR (18.8 mg g⁻¹) compared to FCC-N5 (9.6 mg g⁻¹) and FCC (6.7 mg g⁻¹). Mycorrhizal infection rates were higher on FR soils even if this difference was only significant for FR-N4 (17 %) compared to FCC-P5 (7 %) and FCC-P5N5 (6 %). Nematode counts are conducted and will be presented in the final version of the abstract.

Keywords: Mineral N, mycorrhiza, phosphorus, root length, Sahel

Effects of Rainfall Intensity on Soil and Nutrient Losses from Fertilised Upland Fields and Farmers' Acceptability in Northeast Thailand

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The losses of soil and nutrients to the water system cause severe environmental problems, such as eutrophication in water systems or land degradation. Especially, agricultural fields are widely recognised as a non-point source of nutrient components. So, the objectives of this study are to evaluate granular compost application comparing with chemical fertiliser or conventional compost from a viewpoint of reducing soil and nutrient losses under various rainfall intensities of 15, 30, 45 and 60 mm hr⁻¹, and to discuss the farmers' acceptability on promoting organic farming for decreasing the amounts of chemical fertiliser applied through farmers' participation for sustainable agriculture in Khon Kaen of northeast Thailand.

The results showed that soil and nitrogen losses from conventional compost plots were significantly smaller than other plots at the rainfall intensity lower than 30 mm hr. But in case of rainfall intensity higher than 45 mm hr⁻¹, the losses from granular compost plot were the lowest among plots. Also, organic matter and carbon losses from the plot applied granular compost were significantly smaller than those applied conventional compost at 95 % confident level. Additionally, the promotions of organic farming through the demonstration on composting and granular compost making were conducted in Khon Kaen. Farmers' acceptability and participating level were discussed through 4 times of workshop including the questionnaire surveys. It was concluded that the deeper farmers' perception led to the higher farmers' participation, and directly it connected to farmers' acceptability for organic farming. For decreasing the amounts of chemical fertiliser applied, granular compost is the one of farmers' alternative, which may contribute to sustainable agriculture.

Keywords: Organic farming, Thailand

Organic agriculture

Oral Presentations	417
CHRISTINE ZUNDEL, LUKAS KILCHER, PAUL MAEDER: What Can Organic Agriculture Contribute to Sustainable Development? — Long-Term Farming System Comparisons in the Tropics	417
PETER JUROSZEK, CHIN-HUA MA, HSING-HUA TSAI, DENG-LIN WU, MANUEL C. PALADA: Organic Farming Research at AVRDC-The World Vegetable Center: Developing Systems for Smallholder Farmers in the Tropics	418
BIRGIT WILHELM: The Organic Tea and the Coffee Market — A Comparison of their Development	419
ANDREAS OSWALD, ADRIANA ARIAS, JORGE CAYCHO: The Potential of Organic Potato Production in the Central Andean Highlands of Peru	420
Posters	421
ASFAW TIHUNE, SAHLE TESFAI: Organic Coffee Production and Sustainable Agriculture: A Socio-Ecological Analysis	421
ABDOLMAJID MAHDAVI DAMGHANI: Organic Farming in Iran: Opportunities and Challenges of Certification, Education and Development	422
SHILPI SAXENA: Organic Vegetables: Regional and Domestic Marketing Constraints and Opportunities for Small-Scale Farmers in East Africa	423
JULIA SCHMITT, VOLKER HOFFMANN: Non-Timber Forest Product Certification in China: Status, Challenges and New Approaches	424
AFRAH MOHAMMED, ANNA KEUTGEN, ELKE PAWELZIK: Quality of Organic Tomatoes Grown in Two Different Locations	425

**TÜLİN YÜCEL, MEHMET BÜLBÜL, HARUN TANRIVERMİS:
Economic and Environmental Assessment of Organic Farm-
ing in Turkey**

426

What Can Organic Agriculture Contribute to Sustainable Development? — Long-Term Farming System Comparisons in the Tropics

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Organic agriculture is an interesting option to agricultural stakeholders because it combines environmental conservation with low-cost technology and access to premium price markets. The organic farming system has proven its advantageous aspects regarding resource efficiency, ecosystem functioning, soil fertility conservation and economic impact in a wide range of experiments and studies in the developed countries of the temperate areas. In low-income countries of the tropics, NGOs and farmers' groups are now increasingly adopting organic techniques as a method of improving productivity and food security. Despite the high demand of producer organisations, development agencies, national authorities, and international donors for secured data regarding the agronomic, ecological and economic performance of organic agriculture in developing countries, no systematic comparisons between organic and conventional farming systems have been conducted which allow long-term statements in these areas. The Research Institute of Organic Farming (FiBL), together with its partners, is presently establishing long-term farming systems comparisons in various agro-ecological and agro-economic contexts to study the various parameters which are essential for sustainable development. To present, three study areas have been selected: **(a)** a sub-humid area in Kenya where farming is subsistence-oriented; **(b)** a semi-arid area in India where cotton is produced for the export market; and **(c)** a humid area in Bolivia where perennial fruits and cacao are produced for the domestic and the export market. The key elements in these comparisons are long-term exact field trials. They are completed with short term trials under on-farm conditions and with farm surveys. This network of systems comparisons in the tropics is expected to **(1)** bring the discussion about the benefits and drawbacks of organic agriculture on a rational basis; **(2)** contribute to identification of challenges for organic agriculture, which can subsequently be addressed in a systematic way; **(2)** provide physical reference points to stakeholders in agricultural research and development and thus support decision making and agricultural policy dialogue at different levels.

Keywords: Africa, Asia, comparison, economic performance, Latin America, long-term experiments, organic agriculture, productivity, resource efficiency, soil fertility

Organic Farming Research at AVRDC-The World Vegetable Center: Developing Systems for Smallholder Farmers in the Tropics

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A six-hectare conventionally farmed research area at AVRDC was converted to an organic farm. It has been in a transition period since 2004. During the transition period, vegetable, field crops such as rice, sweet corn, and sweet potato, green manures and catch crops, banana, and tropical fruit trees are grown to increase the biodiversity of the area. Our research on organic production technologies initially focused on tomato, vegetable soybean, and cabbage. In 2006, research work started on organic sweet pepper, cucumber, and the intercropping of fruit trees with vegetables.

From 2004 to 2006, tomato trials to compare commercial organic and conventional production on six farms in Taiwan were conducted using two virus-resistant varieties developed at AVRDC. In two out of three farm pairs, mean marketable fruit yields across varieties were significantly higher on the conventionally managed farms compared to organic farms. However, one of the three organic farmers who was observed to have superior crop management skills attained not only a fruit yield comparable with his conventional counterpart, but also significantly higher fruit lycopene content and consequent higher health benefits. The use of virus-resistant tomato varieties, proper crop management, and timely application of effective biopesticides were most likely the reasons for his success. Farmers' crop management skills are an important component for successful organic farming and need to be upgraded to ensure their competitive success in relation to conventional farming.

The performance of traditional and modern tomato varieties was also evaluated on-station. The performance of one modern virus-resistant variety was outstanding, while traditional varieties that are not virus-resistant hardly produced any fruit. This confirmed that good crop management skills along with the use of superior varieties are important. The knowledge and experiences gained from our organic farming systems research in Taiwan is developing approaches that could be applied in other tropical and sub-tropical countries with many small-scale farmers who are seeking to expand their organic agriculture programs.

Keywords: Biopesticides, farmer, management skills, organic, small-holders, sub-tropics, tomato, training, tropics, variety, vegetable

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The Organic Tea and the Coffee Market — A Comparison of their Development

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When the first teagarden in Sri Lanka was converted to organic agriculture in 1986, simultaneously in Mexico the first smallholder organisation started the production of organic coffee. Comparing the development of the two perennial crops in the market, the organic coffee production is much more developed worldwide. In 2005 18.9% of the coffee production in Mexico has been organic. In Sri Lanka the total organic area (including tea) doesn't achieve 1%. In Darjeeling the organic production of tea is more common and started in 1988. Today 30% of the 87 Darjeeling tea gardens are converted to organic agriculture, but the total organic production in India is less than 0.5%.

The main challenges in the organic tea production to comply with the organic principles are the nutrition of tea bushes with organic fertilisers (mainly compost) and the prevention of diseases and pests, which is only possible if the ecosystem in the garden is well established. In addition the different requirements for certification depending on the export country about documentation and traceability have to be fulfilled.

From the beginning organic coffee was mainly produced by small holders and exported by cooperatives. There is a new trend in the tea production, which supports small holder organisations producing their own organic tea. In comparison with coffee tea is finally processed in the country of origin. Special 'know how' and machinery is hardly available for small holders. Small holders pick their tea and sell it as "fresh leaves" to the factories. In 2000 the EU supported, together with European NGOs and a local organisation the construction of the first tea factory for small farmers in Kerala, South India. In November 2003 the factory was inaugurated and belongs now to the Sayhadri Farmers consortium, producing their own smallholder organic tea.

Keywords: Organic coffee, organic market, organic tea, smallholders

The Potential of Organic Potato Production in the Central Andean Highlands of Peru

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The Central Andean Highlands of Peru and Bolivia are the centre of origin of the potato. Indigenous potato landraces are cultivated by small-scale farmers in fields located 3500 to 4200 m above sea level, in erratic and harsh climatic conditions and on soils which often have a low inherent potential for crop production. For many centuries farmers grow potato as their major staple food and/or cash crop and developed a unique richness of potato production practices.

Subsistence farmers in remote regions still use mainly organic inputs for crop production while more commercially oriented farmers in the vicinity of market centres use high amounts of inorganic fertilisers and chemical pesticides.

In 2005/06 and 2007 diagnostic surveys were conducted in 5 regions of the Andean Highlands of Peru to analyse farmers' practices for soil fertility management and to create an inventory of organic production techniques, which are still in use or which are being 'rediscovered' by farmers changing to organic crop production. Furthermore, results from field experiments assessing the efficiency of organic and chemical fertilisers contributed to the evaluation of organic and inorganic production systems.

The regional study showed that organic technologies exist primarily for soil fertility management and fertiliser use, while knowledge on biological control of pests and diseases is more limited to remote communities with restricted access to chemical inputs. More than 30 different technologies were recorded and will be evaluated in the future. To some extent farmers are aware of health problems related to pesticide use and claim that the organoleptic qualities of organically produced potatoes are superior to the ones cultivated with chemical inputs. However, low product prices and a market demanding a high product quality induce farmers to rely on chemical inputs for pest control and fertiliser management. Organic potato production is possible in some regions of the Andean Highlands, especially where diseases like *Phytophthora infestans* or viruses are absent and infrastructure allows for an unproblematic market access. In this respect CIP (International Potato Center) is developing an integrated approach for potato production in low-input systems, which comprises soil fertility and pest and disease management.

Keywords: Andean highlands, International Potato Center, organic potato production, soil fertility management

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Organic Coffee Production and Sustainable Agriculture: A Socio-Ecological Analysis

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Coffee used to be the main agricultural commodity of Ethiopia for long period. The last thirty years have experienced repeated fall in price at the global market. This has affected the country's foreign exchange earnings in general and smallholder producers in particular. Moreover, the repeated price fall has negatively impacted the livelihood of about 25 % of the country's populations who directly or indirectly depend on coffee industry. This makes it recommendable for the country to search for another alternative means of being competitive. Oromiyaa Coffee Farmers Cooperative Union Ltd. is engaged in the production and marketing of Organic and Fair-trade coffee since the last four years.

This case study is conducted at Limmuu Koossaa District. Three coffee producing sites were selected. Each site is sampled with characteristic attributes relevant to organic coffee production, cooperative membership, non-organic coffee production and non-cooperative membership.

The study employed a socio-ecological analysis of organic coffee production in contrast to non-organic way of coffee production. The impacts of these components on environmental sustainability, optimal production and equity are measured. The study utilised both primary and secondary data. The indicators for these performances were identified as the state of resources and the management efficiencies of these resources in each sample site. A series of variables are identified for investigation under each indicator, whose impacts on environmental sustainability, productivity or equity are evaluated in each site.

The study disclosed that organic coffee production is ecologically sound and economically rewarding when compared to non-organic way of coffee production. Social and institutional performances, as examined for transparency and benefit sharing of primary producers, of the system of production in the study area are found to be as poor as in non-organic system of production. The results show that organic coffee production, as implemented in Baabboo, did not attain social justice and equity. It has not yet attained a 'break-away' from similar constraints of non-organic system of production. The study concludes that sustainability of organic coffee production at Baabboo is confronted with potential dangers. The study, thus, provides signals of policy implications of the challenges and opportunities of organics.

Keywords: Socio-ecological analysis

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Organic Farming in Iran: Opportunities and Challenges of Certification, Education and Development

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Organic farming is a holistic production management system which promotes and enhances health of agroecosystem related to biodiversity, nutrient biocycle and soil biological and microbial activity. Organic agriculture is defined worldwide as “farming without the addition of artificial chemicals”. Organic certification focuses on the methods and materials used in agricultural production. There are Three main requirements for certifying these products: a) the methods and materials used in production must meet organic standards, b) there must be clear and ongoing documentation of these methods and materials, and c) there must be a paper trail tracing a product back to its production site, in order to verify the methods and materials used in its production. Farmland area in Iran is 11–13 million ha in which most of it can be classified as traditional farming systems which smallholder farmers are involved in subsistence agriculture. As many farmers in their small farms and gardens never use agrochemicals and use sustainable approaches for crop production during land preparation, crop nutrition, soil fertility as well as pest, disease and weed management, their agroecosystems are potentially organic or can be easily converted to organic. These farmers grow a wide range of crops (including cereals, root crops and medicinal plants), fruits (nuts, apple, pomegranate, citrus, fig and grapes) and vegetables that all have an expanding organic market worldwide. There are, however, some obstacles in certifying these products as organic. According to the EU rules, each farmer has to be inspected annually. In Iran as a developing country where many farmers have small farms, such a system is unpractical and excessively expensive. Group certification can be considered as an alternative for these farmers in which farmers’ groups that may consist of a hundred to several thousands small scale producers will be co-certified as a unit. Farmers’ education about principles and objectives of organic farming and short- and long- term benefits of organic certification also should be considered.

Keywords: Farmer education, group certification, Iran, organic certification

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Organic Vegetables: Regional and Domestic Marketing Constraints and Opportunities for Small-Scale Farmers in East Africa

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Though certified and non-certified organic farming are being practised in East Africa by small-scale farmers, most of their products are geared at the export markets of Europe and the US. The certified cash crops include cotton, coffee, tea, spices and fruits. Fresh non-certified and certified organic vegetables, latter also for export, are produced in Kenya and Uganda. As vegetables in general are important for nutrition due to their vitamin, mineral and iron content, the importance here is placed on this food crop.

The local markets for organic vegetable produce have hardly been developed, as price premiums for extra quality cannot necessarily be paid by most of the population. Lack of awareness concerning the availability of organic products, and consumers' perception of certain African vegetables of being of low value are other main factors for organic products being only a niche market in East Africa. On the supply side, poor infrastructure, lack of market information and products quality are further constraints for bringing organic vegetables adequately on the regional and domestic market. Currently, there is a shift of organic vegetable production from developed to developing countries, as demand outdoes supply in the former and increases the demand for organic vegetables from developing countries. But the world market is very volatile. Once demand in the richer countries diminishes, it will have a strong effect on the producer side, if small-scale farmers only target export cash crops without building a domestic market. Hence, organic vegetable production in (East) Africa can only be sustainable, if the regional and domestic market can be successfully targeted as well. Besides the increase of international demand for organic vegetable produce, there is a growing demand in Africa. In East Africa there are specialised outlets mostly in capital cities. Sales are also increasingly conducted through non-specialised outlets (supermarkets). The clientele consists of expatriates and some richer nationals. These local consumers would be willing to pay reasonable price premiums (range: 30—50%). However, production and marketing costs (certification) are very high for organic vegetables. This has to be taken into account by assessing the regional and domestic market opportunities.

Keywords: Domestic & regional market, East Africa, organic vegetables

Non-Timber Forest Product Certification in China: Status, Challenges and New Approaches

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Non-timber forest products (NTFPs) are essential to most rural livelihoods in China. Their utilisation has a long history and markets are well established. To date, China processes and trades more wild products than any other country, with markets for certified NTFP products rapidly evolving. Still, the implementation of NTFP certification schemes is lagging behind.

Certification schemes for NTFPs in China include organic certification, responsible forest management standards, i.e. landscape-based certification, product quality certification and Fair Trade.

Most certification systems in China are organic schemes of large agriculture companies, producing mostly for export. To target small-scale farmers with a diversity of products, landscape-based schemes are needed. These are, however, difficult to implement outside state forest areas, due to small-size subdivision of landscapes and differing tenure rights. Moreover, in landscape schemes, lack of farmer organisation, lack of information and unclear responsibilities make product quality uncertain.

Product quality certification requires controlled value chains of single products to achieve high consumer security. However, research showed that in China NTFP value chains build on complex network of traders, many of them operating informal. The low level of vertical coordination within these value chains makes product traceability almost impossible.

Therefore, NTFP certification in China requires the development of new approaches, such as controlled out-grower schemes with alternative value chains for product traceability to combine the improvement of product quality and establish sustainable management systems, for the benefit of producers and consumers.

In the framework of a Sino-German research project between the Chinese Academy of Forestry (CAF), the World Agroforestry Centre in China (ICRAF-China) and Hohenheim University, the aspects of producing, collecting and processing NTFPs within different value chains are analysed.

The poster presentation will feature NTFP certification status and challenges in detail, as well as, present new approaches and their requirements to succeed in China.

Keywords: Certification, China, nTFPs, value chains

Quality of Organic Tomatoes Grown in Two Different Locations

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Increased consumer awareness of food safety issues and environmental concerns has contributed to the growth in organic farming over the last few years. Generally, the public perceives organic foods as being healthier and safer than those produced through conventional agricultural practices.

The purpose of this study was to investigate the variations of some quality parameters as nutritional and technological properties in fifteen selected tomato cultivars from Germany, which differ in their colour, size and shape. These cultivars were grown in two locations: Ellingerode, Hessen (A) and Schönhagen, Thuringia (B).

Results showed significant differences between and within the locations. Regardless the location the highest content of ascorbic acid was found in Resi Gold (23.1 mg/100g FM) and Phantasia F1 (22.3 mg/100g FM), the highest value of phenolic compounds was found in Cuban Pink (150 mg/100 ml juice) and the lowest value was found in Ferline F1 (42.6 mg/100 ml juice). Resi Gold and SO30A expressed the highest concentration of dry matter, whereas the lowest one was found in Hybrid-2. Generally the highest content of juice was found in Phantasia F1 (54.1%) and lowest in Matina (23.9%). Ferlina F1 and Matina expressed the highest glucose and fructose levels in both locations. However, the lowest concentrations were found in Hybrid-2 and Celsior × Matina F6.

These results confirmed variations among the cultivars within and between the locations. Despite these variations, still there is a great possibility of use of these tomato cultivars for various aspects in high quality food industry for human consumption. For instance, we may recommend Matina for tomato paste production due to its high pulp content in fruit. Celsior × Matina F6, Gold × Matina, Resi Gold, Phantasia F1, Goldene Königin and Rosa Roma can be recommended as the best cultivars for human nutrition due to their high ascorbic acid content. Furthermore, Cuban Pink, Matina and SO30A can be recommended for human nutrition due to their high phenolic compounds content.

Keywords: Cultivars, nutritional quality, organic tomato

Economic and Environmental Assessment of Organic Farming in Turkey

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Organic farming is a new production technique, which abstain from or largely excludes the use of farm chemicals, concentrated feeds and additives. Organic farming has been adopted in farms since the mid 1980s by the supports of trade firms in the Western part of Turkey and organic crop and livestock farming has rapidly diversified so far today. Dried sultanas, apricots, figs and hazelnuts were the first crops to be produced organically and today, 110 different crops and livestock products are produced organically. Organic farming planted areas reached to 170,000 ha, which corresponds to 0.70 % of the total farmland and the organic production was approximately 220,000 tons in 2006.

Organic production is organised based on the standards and certification systems of the importing countries, which are mainly the EU countries. In order to provide a legal framework for the organisation and enhancement of the organic farming sector, an organic farming law numbered 5262 was drafted and made effective on December 1, 2004. The organic industry brings direct benefits to producers in terms of improved agricultural techniques, reduced costs of external inputs, improved environmental value and food quality.

The hypothesis of this study aims to pursue the question whether organic farming can contribute to the welfare of producers and environmental preservation in agriculture. The results of the research carried out on farm level indicate that average yields of organic crops are generally low, prices received by farmers, labour requirements and the net profit per hectare of planted area is higher than conventional farming in Turkey. Organic farming has a positive contribution to producer welfare, and producers are inclined to maintain and expand the organic farming in general. In this paper, evaluation of organic farming is reviewed in the light of the recent research results on the farm level as well as recent developments in national level in terms of production, export volume, domestic consumption, legal and institutional framework in Turkey. Also, the problems of organic producers are discussed and policy proposals in organic industry is proposed in relation with the accession to the EU.

Keywords: Organic farming, Turkey

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Food production, food quality and food safety

a)	Resource use and fertility management	429
b)	Water use: current situation and perspectives	459
c)	Cropping techniques in dry and humid areas	479
d)	Plant protection	493

Resource use and fertility management

Oral Presentations	432
SAMSON HUNI, HELMUT HERZOG: Drought Effect on Yield, Leaf Parameters and Evapotranspiration Efficiency of Cowpeas	432
ESTHER MITTERBAUER, ELISABETH ESCH: Germplasm Diversity for Resource Protection in Crop Production	433
WAKENE NEGASSA CHEWAKA, ABDENNA DERESSA, FITE GETANEH: Integrated Use of Organic and Inorganic Fertilisers for Maize Production	434
BHUWON STHAPIT, V. RAMANATHA RAO: “Grassroots Breeding”: A Way to Optimise the Use of Local Crop Diversity for the Well-Being of People	435
Posters	436
RODRIGUE DIOGO, ANDREAS BUERKERT, EVA SCHLECHT: Horizontal Nutrient Fluxes in Urban and Peri-Urban Gardens of Niamey, Niger	436
GHOLAMALI PEYVAST: Commercial Compost Increased Yields and Decreased Nitrate Amount of Several Vegetables	437
SAAD ABDEL RAHMAN SULIEMAN, TAG EL-DIN E. M. HAGO: The Response of Common Bean (<i>Phaseolus vulgaris</i> L.) to Phosphorus as Influenced by Farmyard Manure	438
OLAJIRE FAGBOLA, OLADUNNI AYOOLA OJO: Responses of Three Tomato Cultivars to Organomineral Fertiliser and Arbuscular Mycorrhizal Fungi under Field and Greenhouse Conditions	439
AWADALLA ABDALLA ABDELMULA, ISHRAKA KHAMIS ABUANJA: Genotypic Response, Yield Stability, and Association Between Characters among some of Sudanese Faba Bean (<i>Vicia faba</i> L.) Genotypes under Heat Stress	440
ELGILANY A. AHMED, ABUBAKR MOHAMED, KHALID SIDDIG: Economics of Faba Bean Production and Marketing in Northern Sudan	441

- JONATHAN C. ONYEKWELU, OLAWOLE J. FAYOSE:
Effect of Storage Methods on the Germination and Proximate Composition of *Treculia africana* Seeds 442
- FRANZISKA BERAN, SUJIT ADHIKARY, SANKAR GAYEN, CHRISTIAN ULRICHS, ARUNAVA GOSWAMI:
Genetic Polymorphism of *Dolichos biflorus* L. in India at the Seed Storage Level 443
- ELFADL ELFADL:
Effect of Nitrogen Rate and Seed Density on Safflower (*Carthamus tinctorius* L.) under Low-Input Farming System 444
- SILKE WILL, MARIANNE SCHÜTT, CHRISTINE TISCH, TORSTEN MÜLLER, VOLKER RÖMHELD:
Efficiency of Foliar Micronutrient Fertilisation in Lychee 445
- ANNETTE WEIDNER, FOLKARD ASCH, GERHARD H. BUCK-SORLIN, ANDREAS BÖRNER:
QTLs for Salt Resistance Vary with Development Stage in Field-Grown Barley 446
- SHAMA DAWELBEIT, CHRISTIAN RICHTER:
Effect of Water Intervals and Organic Fertilisation on Yield and Quality of the Muskmelon cultivar ‘Galia’ 447
- SUCHIT SHRESTA, FOLKARD ASCH, MATHIAS BECKER:
Phenological Responses of Rice Genotypes to Varying Thermal Environments in Nepal 448
- SUNILDA TERRE, FOLKARD ASCH, JON PADGHAM, RICHARD A. SIKORA, MATHIAS BECKER:
Influence of Root Zone Bacteria on Root Iron Plaque Formation in Rice Subjected to Iron Toxicity 449
- FOLKARD ASCH, TAM AUNG, MATHIAS BECKER:
Root Iron Plaque Formation as Resistance Mechanism to Iron Toxicity in Lowland Rice 450
- SABINE STÜRZ, FOLKARD ASCH, MATHIAS BECKER:
Field Validation of a Quick Screening Method for Iron Toxicity in Lowland Rice 451
- THERESA KABAKERIS, SUJIT ADHIKARY, CHRISTIAN ULRICHS, ARUNAVA GOSWAMI:
Evaluation of Drought Tolerance in Some Rainfed Upland Rice Cultivars 452
- AWADALLA ABDALLA ABDELMULA, SALIH ADAM IBRAHIM SABIEL:
Genotypic and Differential Responses of Growth and Yield of Some Maize (*Zea mays* L.) Genotypes to Drought Stress 453

STEFAN HAUSER: Maize Yield Response to Mulch, Burning and Insecticide Application on an Ultisol	454
OLAJIRE FAGBOLA, PETER WUSU OGUNGBE: Productivity of Three Maize Cultivars as Affected by Organomineral Fertiliser and Arbuscular Mycorrhizal Fungi under Greenhouse Conditions	455
JOSE ALOISIO ALVES MOREIRA, MARCIA THAIS MELO CARVALHO, ALCIDO ELENOR WANDER, AGOSTINHO DIRCEU DIDONET: Growth and Productivity of Maize Cultivated in No-Tillage in Succession of Different Cover Crops	456
VINCENT ADURAMIGBA-MODUPE, JOHN IDOWU: Tillage and Fertiliser Effects on Sole Maize Cropping in a Degraded Nigerian Alfisol	457

Drought Effect on Yield, Leaf Parameters and Evapotranspiration Efficiency of Cowpeas

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Two experiments with six cowpea [*Vigna unguiculata* (L.) Walpers] genotypes were carried out in the greenhouse to study the response of yield and related parameters including total leaf area (LA), specific leaf area (SLA), intrinsic transpiration efficiency (TEi), evapotranspiration efficiency (ETE) and stem mass density (SMD) under drought at the generative phase.

In experiment 1 pod mass plant⁻¹ ranged from 51 to 62g under well-watered (ww) conditions with similar pod mass under water deficit (wd) conditions, except ExUkwala which produced very few small pods. The seed yield plant⁻¹ ranged from 38 to 49g for ww plants and 32 to 36g under wd, except ExUkwala. Single grain weight (SGW) of ww treatments ranged from 101 to 230mg, but it ranged from 48mg, 109 to 146 and 190mg under drought.

ETE of ww plants varied between genotypes and was positively correlated to three yield parameters. Under wd rank order of ETE was altered and ETE displayed no significant relationship to yield components. TEi of ww plants had a weak positive correlation to number of seeds plant⁻¹, whereas SMD was positively correlated with pod mass. Correlation of TEi to number of seeds plant⁻¹ remained under wd and SMD had a stronger correlation to seed mass and SGW under drought. Under ww conditions LA had no significant correlation to yield, but SLA was negatively correlated to yield components. LA and SLA showed negative correlations to pod mass, seed mass and SGW under wd.

In experiment 2, ExUkwala and Vita7 did not flower. There were similar ww and wd effects. However, sizes of yield components were several magnitudes lower than in experiment 1. Under ww and wd conditions the relationships of parameters to yield components were similar to those in experiment 1. Further, leaf relative water content (RWC) had a positive correlation to SGW under ww conditions, whereas a positive correlation existed between RWC and pod mass, seed mass and SGW under wd.

The data presented here seem to point to a possibility to select cowpea genotypes under drought during the generative phase for their yield performance using parameters like TEi, SLA and SMD.

Keywords: Cowpea, drought, evapotranspiration efficiency, intrinsic transpiration efficiency, stem mass density, *Vigna unguiculata*, yield components

Germplasm Diversity for Resource Protection in Crop Production

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Huge problems in tomato greenhouse production in the tropics are caused by high temperatures. Greenhouses are used to protect plants from destruction due to heavy rainfalls, storms, and insect infestations. For worthwhile tomato production it is absolutely necessary to decrease the greenhouse inside temperature. But the use of more or increasingly powerful cooling systems might be as well uneconomical as resource encumbering. Genetic diversity of heat tolerance of the tomato (*Solanum lycopersicum* L.) has already been described in the literature.

Two strategies were used to evaluate and combine these potentials of resource protection: Reducing the stress factor and finding genotypes adapted to the stressor. The experiments were conducted during different seasons at the experimental facilities of the project „Protected cultivation- an approach to sustainable vegetable production”, situated on the campus of the Asian Institute of Technology (AIT), Klong Luang, Pathum Thani, Central Thailand, and on the campus of the Leibniz University in Hannover, Germany. For the first strategy, we assessed the response of miscellaneous heat tolerant genotypes to different microclimatic conditions aroused by different greenhouse cover materials and ground mulches. We gauged the plant's response to UV absorbing greenhouse cover films and different coloured mulch foils and evaluated the influence of UV and NIR radiation. We evaluated several traits, associated with heat tolerance. For the second strategy the most heat tolerant genotype and a heat sensitive variety were selected and used as parents for building up a segregating F2 population. We evaluated the same traits under high temperature treatment as in the prior experiments. At present we're using AFLPs to build linkage groups. We will be able to map some of the genes responsible for heat tolerance and to create primers as useful tools for plant breeders. Basing upon these results it becomes possible to breed new varieties with better adaptation to heat stress, and reduce the energy consumption for cooling systems.

Keywords: Plant genetic diversity, heat stress, resource protection, *Solanum lycopersicum*, tomato

Integrated Use of Organic and Inorganic Fertilisers for Maize Production

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Integrated nutrient management (INM) is an approach that seeks to increase crop production and safeguard the environment for future generation. However, the current agricultural practices under Ethiopian condition are exploitive type that enhances nutrient mining and an inadequate supply of nutrients is also a key impediment for sustainable crop production. Thus, the objective of the study was to use INM technique to increase maize production in sustainable manner. The study was conducted for three consecutive years (2001 to 2003) on acidic Alfisols of Bako Agricultural Research Center. The treatments of the experiment was control (zero), *Mucuna pruriens* as improved fallow (IF), IF + 55/10 kg N/P ha⁻¹, IF + 37/7 kg N/P ha⁻¹, IF + 4 tons (t) farmyard manure (FYM) ha⁻¹, IF + 2.7 t FYM ha⁻¹, and the recommended rate of NP fertilisers (110/20 kg N/P ha⁻¹). The results showed significant differences among the treatments on maize grain yield in all cropping seasons except for the 2002 due to soil moisture deficit at grain filling stage. The integrated use of IF along with FYM also improved important soil chemical properties, and the uptake of N, P, and K. Moreover, the sole use of IF increased maize grain yield by 75, 56 and 244 % in 2001, 2002 and in 2003 cropping seasons, respectively, over the control treatment. Therefore, the use of IF along with FYM or low rate of NP fertilisers could improve maize production, and productivity in Western Ethiopia. However, further research is required to use *Mucuna* spp to use as feed and/or food to increase its adoption since it recently introduced to the country.

Keywords: Farmyard manure, improved fallow, *Mucuna*, NP fertilisers, Western Ethiopian, maize

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“Grassroots Breeding”: A Way to Optimise the Use of Local Crop Diversity for the Well-Being of People

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Effective maintenance of crop diversity within farming systems has been the subject of number of studies over the last decade. Although the benefits of agrobiodiversity have been widely recognised and encouraged through global conservation and policy awareness initiatives, its use is constrained due limited number plant breeders who can respond to all the needs of the poor farmers. Agrobiodiversity assets that are important for the poor are either being lost or not being optimally use. This is because neither the rural poor nor research and development workers fully appreciate their value and/or manage them well. This loss is often attributed to the green revolution, which, due the needs of the time assumed that the sophisticated plant breeding, led and controlled by professional breeders, is the best way of addressing the farmer's problem and needs. On the contrary, farmer participation in breeding might: 1) improve farmers' access to a wide range of genetic resources for local innovation, and 2) enhance farmers' knowledge and skills in genetic resources conservation and plant breeding. In this paper, we re-examine if farmer participation does improve the availability, access, quality, conservation and utilisation of genetic resources. This paper put forward a step-by-step plant breeding process, which can enhance the capacity of grassroots institutions and farmers to assess existing diversity, select niche specific plant materials, produce sufficient quality seed, and distribute this within the community. We call this process of local crop development “Grassroots Breeding”. Based upon this analysis, together with experience of community-based on-farm management, we conclude that a rethink in current plant breeding approaches is essential if we want to optimise the benefits to poor farmers through the use of genetic diversity at the local level. What are the simple tools that can be used, or are being used, to reach this goal? Such an effort is pertinent given the ever-increasing demands placed on different production systems due to changing climate and farming practices. High levels of on-farm diversity can help mitigate the negative effects of these current trends if communities are empowered for efficient resource use and diversity in agro-ecosystems for improving livelihoods.

Keywords: Agricultural biodiversity, community empowerment, farmer seed systems, grassroots breeding, grassroots institutions, local crop development, participatory plant breeding

Horizontal Nutrient Fluxes in Urban and Peri-Urban Gardens of Niamey, Niger

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Horizontal nutrient fluxes were measured in 4 selected urban and peri-urban gardens of Niamey, capital city of Niger. Two gardens were strongly market-oriented; the other two were mainly cultivated for auto-consumption. Quantification of nitrogen (N), phosphorus (P), and potassium (K) inputs through application of animal manure, urea and irrigation water and determination of nutrient extraction in harvested products took place in the cool dry season 2005/06 (November - February).

For the two market gardens, N inputs through urea and animal manure by far exceeded N extraction in vegetables, resulting in strongly positive partial balances of 256 and 914 kg N ha⁻¹. At 11 and 63 kg N ha⁻¹, N balances in the gardens serving auto-consumption were also positive but to a much lower extent.

For one market garden where cabbage was mainly fertilised with urea, balances for P (-35 kg ha⁻¹) and K (-147 kg ha⁻¹) were negative. In the other market garden animal manure was applied to lettuce and extraction rates of P and K were only 17 % and 43 % of the extraction in the first garden. Consequently, positive horizontal balances for P (84 kg ha⁻¹), and K (115 kg ha⁻¹) were measured in the second market garden. Positive partial balances for P (2 and 27 kg ha⁻¹) and K (11 and 56 kg ha⁻¹) were also determined in the gardens serving auto-consumption.

The results point to an excess application of nutrients, and especially nitrogen, in gardens with a strong market-orientation. To determine the fate of the excess nutrients and conclude on eventual environmental hazards of gardeners' fertilisation strategies, the vertical losses of these nutrients through leaching (N, P, K) and gaseous emissions (N) have to be determined. First results regarding these aspects are presented by Predotova *et al.* in these proceedings.

Keywords: Horizontal nutrient fluxes, market gardens, Niger, urban agriculture

Commercial Compost Increased Yields and Decreased Nitrate Amount of Several Vegetables

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Vegetables are an important component in the diet of rural families in Iran as they provide essential vitamins and minerals. Leaf and bulb vegetables are especially important in Iran and are used in almost all Iranian meals. Although several fields are available on vegetable production, few of these concentrate on organic production methods. This study was conducted to assess the yield and nitrate content of several vegetables i.e. Chinese cabbage (*Brassica campestris* ssp. *pekinensis* Rupr), spinach (*Spinacia oleracea* L.), broccoli (*Brassica oleracea* convar. *Italica*) garlic (*Allium sativum* L.) and green beans (*Phaseolus vulgaris* L.) grown in the field during the cool and warm season 2005 and 2006 at the University of Guilan in Rasht, Iran. Four different levels of commercial compost; 0 (control), 37.5, 75.0, and 150 t.ha⁻¹ were supplied each year to the plants. There was a tendency for the total yield to be highest when fertilised with compost and lowest when the compost was not supplied. All vegetables with the highest compost treatment (150 t.ha⁻¹) gave significantly highest yield which was statistically different from other treatments with lower commercial compost. The significant differences were also found on marketable yield by Chinese cabbage, broccoli, spinach, garlic and green beans. The lowest nitrate content in the leaves and edible parts of mentioned vegetables was observed in 150 t.ha⁻¹ compost treatment followed by 37.5 and 75.0 t.ha⁻¹ compost treatments respectively. By spinach and Chinese cabbage in the petiole were shown the same results with those in the leaf. However, significant differences contents were not found among the treatments by most of the vegetables.

Keywords: Commercial compost, nitrate, vegetables, yield improvement

The Response of Common Bean (*Phaseolus vulgaris* L.) to Phosphorus as Influenced by Farmyard Manure

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A field experiment was conducted in the Demonstration Farm of the Faculty of Agriculture, University of Khartoum at Shambat, in order to investigate the response of common bean (*Phaseolus vulgaris* L.) to the application of phosphorus and farmyard manure (FYM). The experiment was laid out in Split-plot design with four replicates. FYM treatments were allocated to the main-plots, and the phosphorus levels to the sub-plots. Seeds of common bean cv. Shendi were inoculated with *Rhizobium leguminosarum* bv. phaseoli USDA 2669 as a basic treatment. The treatments consisted of two rates of FYM (0 & 2.5 ton ha⁻¹) and five levels of phosphorus (0, 50, 100, 150, 200 kg P₂O₅ ha⁻¹). Triple superphosphate (48 % P₂O₅) was used as a source of phosphorus in the experiment.

The results showed that, phosphorus application did not significantly affect the parameters examined and its effects was sometimes erratic and inconsistent. The beneficial effects of phosphorus to the plants that are grown in Shambat soil are little, due to its heavy clay alkaline nature (calcareous soils promptly converting the phosphorus fertiliser into insoluble forms). On the other hand, FYM application significantly affected soil organic matter and leaf phosphorus content. As a fertiliser, the value of FYM lies in the fact that it increases soil organic matter and thus improves availability of nutrients (especially N, P & micronutrients) to the plants. In addition to that, there was significant effect of the interaction between both factors on some growth and yield attributes (shoot dry weight & 1000 seed weight). This positive interaction may be due to the beneficial effect of FYM application on the availability of phosphorus to the plants. In addition to phosphorus, which was mineralised from the organic matter and became available to plants, organic matter also acts as chelating agents, thereby preventing the formation of insoluble phosphates. Furthermore, the application of organic matter to soil with high pH value not only supplies phosphorus, but during decomposition provides acidic compounds which increase the availability of mineral forms of phosphorus in the soil (i.e., extra CO₂ speeded up the solubility of phosphatic compounds).

Keywords: Calcareous soil, farmyard manure, organic matter, *Phaseolus vulgaris* L, phosphorus application, common bean

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Responses of Three Tomato Cultivars to Organomineral Fertiliser and Arbuscular Mycorrhizal Fungi under Field and Greenhouse Conditions

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Tomato plants are classified as a heavy feeder having high requirement for nutrients. This is a strong limitation to both the quantity and quality of yield in infertile tropical soils. Application of chemical fertilisers is very limited due to logistic and lack of resources for its acquisition by the resource poor farmers. Deleterious effect of chemical fertilisers on the environment is also a critical factor that calls for a more environmentally friendly alternative. There are several tomato varieties that are commonly grown in different parts of West Africa. In this study, we evaluated three most commonly grown cultivars under field and greenhouse conditions to determine how their growth and yield can be improved through the combination of organomineral fertiliser (OMF) and arbuscular mycorrhizal fungi. A $2 \times 2 \times 3$ factorial experiment was used under greenhouse conditions with a completely randomised design while randomised complete block design was used under field conditions. Factors investigated include two levels of mycorrhizal application (with and without); two levels of organomineral fertiliser application (with and without, at the rate of 2.5 t h^{-1}) and three levels of tomato cultivars (Besue, Hausa and Ibadan local). All treatments were replicated thrice and data on yield and growth parameters analysed using ANOVA. Under greenhouse conditions, there was an increase in the number of fruit and fresh fruit weight of Hausa variety inoculated with mycorrhiza under OMF application by 300 % and 85.9 % respectively and were significantly ($P < 0.05$) higher compared to the values obtained for Besue but not significantly different from that of Ibadan local. Similar trends were observed under field conditions. The growth parameters like height and stem girth gave similar trends. It is therefore necessary to understand the mycorrhizal response status and organomineral fertiliser requirements of tomato cultivars before recommending these to farmers. It is possible that the level of fertiliser application in this investigation is not adequate to enhance the yield of Besue cultivar.

Keywords: Arbuscular mycorrhiza, organomineral fertiliser, soil fertility, tomato cultivars, yield

Genotypic Response, Yield Stability, and Association Between Characters among some of Sudanese Faba Bean (*Vicia faba* L.) Genotypes under Heat Stress

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Heat stress is one of the abiotic stresses that affect and reduce yield productivity of faba bean. This study aimed to evaluate the performance and stability of twenty two faba bean (*Vicia faba* L.) genotypes under terminal heat stress. The genotypes were field tested for two consecutive years (2001/02–2002/03) during winter in Sudan, at Shambat (the Experimental Farm of Faculty of Agriculture, University of Khartoum). To induce heat stress, three sowing dates were used, namely: S1 (optimum), S2 (14 days later than optimum), and S3 (28 days later than optimum). The genetic variability, yield stability and correlation between yield, yield components and other vegetative traits were determined. The results showed that the induced terminal heat stress was severe enough to cause significant reduction in yield and most of the studied characters. Significant differences between genotypes for most of the studied characters were found. Some genotypes tolerate slight heat stress (S2), but become susceptible under severe heat stress (S3) and vice versa. Under slight heat stress, genotype C.52/1/1/1 was highly stable, gave the highest yield and was moderately tolerant to heat stress, whereas under severe heat stress, genotypes C.52/1/1/1 and C.42 showed the highest yield, were highly stable and moderately tolerant to terminal heat stress. Significant positive phenotypic correlations for seed yield/plant with its components: number of podded nodes/main stem, and number of pods/plant were obtained. These two components were positively and significantly correlated with each other, but negatively and highly significant associated with 100-seed weight. Seed yield/plant was positively correlated with dry matter/plant, harvest index and plant height in both years. Positive and significant correlation of seed yield/plant with 100-seed weight and seed yield (kg/ha) was observed. It could be concluded that the high yielding genotypes under terminal heat could be used to improve heat tolerance in faba beans and give possibilities of extending production of faba bean in the non-traditional areas. Moreover, the traits that exhibited strong and positive association with yield could be used as selection criteria for improving faba bean under heat stress conditions.

Keywords: Correlation, faba bean, genotypic, heat stress, stability, Sudan, variability

Economics of Faba Bean Production and Marketing in Northern Sudan

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Faba bean is the most important food legume in Sudan. It makes up a major part of the daily diet for the population. Moreover, it plays an important role in sustaining the productivity of the farming systems through the fixation of atmospheric nitrogen. The northern region of Sudan is considered as one of the main supplier of faba bean in the country. The crop is commonly produced under pump irrigation from the River Nile. The production and marketing of the crop in the region has faced manifold problems namely low level of productivity, high high cost of production, fluctuation of prices, inadequate market credit and weak marketing arrangements. This paper describes the study of the economic aspects of production and marketing of faba bean in the region.

The research revealed that the irrigation water cost constituted 26 % of the total variable cost for faba bean production, while the transportation costs amounted 64 % of the total marketing cost. The actual productivity of faba bean in the region was found very low, 450 kg feddan⁻¹ (ca. 1070 kg ha⁻¹). The yield gab with the potential yield obtained in this region by ICARDA (International Center for Agricultural Research in the Dry Areas) amounts 50 %.

The study detected further that the most important factors that significantly affect the productivity and the marketable surplus were the number of irrigation events, type of scheme, source of irrigation, seed rate, credit availability, farmers' educational level, the reserved amounts for household consumption and the produced quantities of the crop. The study concluded that faba bean production contribute significantly to farm sustainability and alleviates malnutrition in the region. However, the actual production and marketing constraints restrict the sustainability of this important crop. So, the cooperation between international organisations and governemental institutions should tackle the hindrances of faba bean production and establish adequate market infrastructures in the region.

Keywords: Food safety, yield improvement, faba bean, Sudan

Effect of Storage Methods on the Germination and Proximate Composition of *Treculia africana* Seeds

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The seeds of *Treculia africana* (African breadfruit) are widely consumed in West African, especially among rural dwellers, thus playing important role in food security, economic empowerment and rural employment. The effect of storage methods (ambient room condition, refrigerator, deep freezer and under the sun) on the germination and proximate composition of *T. africana* seeds were investigated. Seeds were stored for eight weeks and were subjected to germination trials and proximate composition at the end of each week. Some seeds were sown immediately after extraction, which served as control. Germination of seeds under control and those subjected to some storage methods started 10 days after sowing. Both storage methods and storage duration had significant effect ($p < 0.05$) on the germination. For storage methods that did not kill the seeds, there was significant and progressive decrease in germination as storage duration increased. Storage in deep freezer, under the sun and ambient room condition (for longer than one week) resulted in the death of *T. africana* seeds. Better germination results were obtained from seeds stored in refrigerator for up to four weeks, beyond which further storage killed the seeds. Except for one to two weeks refrigerator storage, germination of seeds under control was significantly higher than that from all the storage treatments. Fresh *T. africana* seeds had carbohydrate, crude protein, moisture, crude fibre, ash and ether extract (fat) contents of 38.26, 17.67, 3.82, 15.85, 3.97 and 15.85 %, respectively. The proximate compositions of the fresh seeds were generally higher than those of seeds subjected to storage treatments. Storage methods and storage duration significantly affected ($p < 0.05$) proximate values. Storing of *T. africana* seeds in the investigated methods will lead to poor or no germination, with germination becoming poorer as storage duration increases. Until appropriate storage method is discovered, the seeds will have to be sown immediately after extraction. The decrease in some proximate compositions of *T. africana* seeds subjected to different storage treatments implies a decrease in the nutritive values of the seeds, thus adversely affecting its importance as food (nutritive) supplement for humans and animals.

Keywords: African breadfruit, germination, proximate composition, storage methods, *Treculia africana*

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Genetic Polymorphism of *Dolichos biflorus* L. in India at the Seed Storage Level

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Horse gram, *Dolichos biflorus* L., is cultivated in many drought prone regions of eastern India by poor farmers. The nutritional and medical values of horse gram have been reported by scientific groups. Apart from the traditional agricultural aspects of seed storage proteins, these seeds are rich in lectins. Lectins are carbohydrate-binding proteins or glycoproteins which are highly specific for their sugar moieties. Lectins occur ubiquitously in nature. They may bind carbohydrate moiety as such free in solution or carbohydrate moiety which is a part of protein/particulate body. They agglutinate cells and/or precipitates glycoconjugates.

Horse gram lectins (DBA) show specificity towards sugar moieties like N-acetyl Galactosamine. DBAs are differentially expressed in seeds, stems, leaves, and roots. The seed lectin and plant lectin genes are different in 116-bp 5'-upstream region. Recently the crystal structure of horse gram plant lectins has generated considerable interest in the scientific community. The unusual quaternary structure variation observed in this group of lectin raises possibilities for the role of DBAs in receptor cross-linking and simultaneous signal transduction from multiple receptors on the cell surface. DBAs are widely used as markers for neuronal pathways, kidney, red blood cells, T-cells, and other epithelial cell surfaces in the mammalian body.

In order to identify the structural variation in the polypeptide sequence of these lectins, a field collection of different horse gram cultivars from ethnic farming communities of eastern India was undertaken. A total of 40 germplasm were collected with the presumption, that seeds have been used long time by these farmers. Cumulative stress from associated environmental factors over a long duration may have influenced the lectin dimmers either at the nucleotide or polypeptide level. Our results showed that the 40 cultivars can be grouped into five groups. Further characterisation of these germplasms at the molecular level is ongoing.

Keywords: *Dolichos biflorus*, genetic polymorphism, horse gram, lectin

Effect of Nitrogen Rate and Seed Density on Safflower (*Carthamus tinctorius* L.) under Low-Input Farming System

ELFADL ELFADL

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Today's agricultural production depends heavily on in-organic inputs which result in direct negative environmental effects. To have a sustainable agricultural production, agronomists have proposed several systems such as low-input and organic farming systems. It is necessary to develop a recommendation programme that adjust N- rate and seed density to crop requirements. To investigate the effect of nitrogen fertilisation and crop density on yield, yield components, oil content and growth characteristics of safflower, three accessions (Sabina, Saffire, BS-62915), three N-rates (0-40-80 kg ha⁻¹) and three crop densities (50-100-150 seeds m⁻²) were used. The experiment was carried out at two different locations (Germany-Ihinger Hof, Switzerland-Wil) for two seasons using a 4-replicated split-plot design. N-fertiliser was applied at rosette stage. Statistically, the nitrogen rate did not have a significant impact on all investigated traits. This may be interpreted as ability of safflower to use residual soil-N efficiently. Nitrogen rate effect on yield considerably varied across years. Hence, spatial and temporal variability should be considered for optimum N-rate. Seed density had a significant effect on seedlings m⁻², crop canopy, days to maturity, plant height, plants m⁻², yield, seeds/plant, heads/plant, branches/plant and oil yield. Low seed density (50 seeds m⁻²) had significantly the highest seeds/head, heads/plant and branches/plant. Effect of seed density was not significant for oil, biomass yield, harvest index and seeds m⁻². These results explained that safflower is a "plastic" crop, able to compensate for low plant density. Density of 100 seeds m⁻² with application of 40 kg N ha⁻¹ could be recommended as a rational agronomic package for production of optimum oil yield.

Keywords: Low input system, nitrogen fertiliser, safflower, seeds density, oil seed

Efficiency of Foliar Micronutrient Fertilisation in Lychee

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Photooxidative stress during winter in northern Thailand upland was identified as a possible reason for chlorosis on lychee leaves mainly appearing at the 2nd youngest flush at south/south-west exposed branches. This is probably due to a missing compensation of photooxidative stress caused by the widespread extremely low boron and/or zinc nutritional status of lychee fruit trees. Affected plant parts show reduced or missing flower induction and fruit set, leading to considerable economical losses. To decrease the development of free radicals and to increase their detoxification for remediation of transient chlorosis, optimal boron and zinc supply are necessary.

Foliar application is an adequate measure to reduce acute deficiency rapidly and side-specific. Compared to soil fertilisation, foliar application can reduce the application rate and therefore the costs considerably. However, the efficiency of common foliar spraying of zinc mainly on the upper side of the leaves is yet very limited in Lychee and other subtropical fruit trees.

The main objective of this study is to improve the effectiveness of foliar fertilisation in lychee and to get a better understanding of the underlying mechanisms of foliar micronutrient penetration using lychee and soybean as examples.

Boron was applied via boric acid labelled with ¹⁰B to individual leaves of ¹¹B-pretreated plants. For experiments on zinc penetration and translocation, ⁶⁵Zn was applied in the isotope laboratory at Hohenheim.

Different surfactants were tested on their physical-chemical properties and on their performance promoting boron and zinc penetration and translocation to sink regions in the plants.

The relevance of upper and lower leaf surface as well as plant nutritional status for penetration success will be presented and discussed.

Keywords: Boron, foliar fertilisation, lychee, micronutrient penetration, micronutrient translocation, photooxidative stress, zinc

QTLs for Salt Resistance Vary with Development Stage in Field-Grown Barley

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Salinity is among the most serious threats for crop production, especially in regions with unreliable rainfall patterns. To sustain agricultural use of affected areas, genotypes are needed that are sufficiently resistant to salinity to offset the farmers' investment and decrease famine hazards. Detailed knowledge of the traits involved in salinity resistance is imperative to successfully breeding tolerant varieties. Molecular trait markers could facilitate this process. Phenotyping of mapping populations under saltstress conditions and computation of QTLs can detect markers closely linked to the genes responsible for salinity resistance. The winter barley mapping population W766 ('Angora' × W704/137) was subjected to saltstress at germination in climate chambers (IPK, Germany, 100 lines, 4 salt concentrations 0–2.5% for 10 days, germination score 1–9 of 10 replications and from the vegetative stage to maturity in a field trial (Herat, Afghanistan, 100 lines, 12.04.–05.05., 2 treatments, EC = 0.8 and 3.2 mS cm⁻¹, 3 replications). Aboveground biomass was sampled 21 days after salt application and at maturity. Dry matter, K and Na concentrations were measured at the vegetative stage and yield components were determined at maturity. QTLs were calculated using the QGENE software. Germination under saline conditions was related to QTLs on linkage groups 3H and 5H confirming earlier results for the OWB and Steptoe-Morex mapping populations. Evaluation of salt responses in yield components using principal component analysis discriminated 4 groups of genotypes within the mapping population, namely tolerant and susceptible includers and susceptible and resistant excluders. From the germination test, the five best and worst performing lines were found in the groups of tolerant includers and resistant excluders, respectively. Thus, QTLs originating from germination responses to salinity cannot reliably indicate resistance strategies realised in later developmental stages. A QTL related to sodium uptake not identified from the germination test was found on chromosome 1H in the field trial. However, one QTL responding to saltstress on chromosome 3H was found in both development stages and was related to yield and yield reduction in the later developmental stages, probably indicating a gene location related to translocation of carbohydrates. Studies are ongoing to further corroborate these findings.

Keywords: Afghanistan, development stage, yield components, barley, salt resistance

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Effect of Water Intervals and Organic Fertilisation on Yield and Quality of the Muskmelon cultivar 'Galia'

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Muskmelon (*Cucumis melo* L.) a new export crop in Sudan, is expected to play a significant role in agriculture and farmers' income. As Gezira soils are poor in organic matter (< 1 %) and have - as Vertisols - physical limitations, an experiment was conducted to test the effect of water intervals and organic fertilisation on quantity and quality of muskmelon. It was a split-plot design with 2 water regimes (irrigation all 7 or 14 days) occupying the main plots while organic fertilisation as farm yard manure (FYM) in 4 levels was assigned to the sub plots. Nitrogen as urea and phosphorus as TSP were added. The total yield represented by exportable yield, locally marketable yield and total yield was recorded. Quality tests represented by physical and chemical characteristics such as total soluble solids (T.S.S.) were determined.

The results showed that exportable, locally marketable and total yield were significantly affected by irrigation. The highest yields were obtained by 7 days watering. Application of FYM affected significantly the exportable, locally marketable and total yield with the highest values at 5.0, 7.5 and 7.5 t ha⁻¹ of applied manure, respectively. The increase in the exportable yield was highest compared to others, and was 29 % higher than the control. The exportable yield was significantly affected by interaction effects of manure and irrigation. The highest exportable yield of 1.2 t ha⁻¹ was recorded at 7 days irrigation intervals with combination of 5.0 t ha⁻¹ of manure. The quality test revealed by T.S.S. showed that the highest level was attained at 7.5 t ha⁻¹ of applied FYM and 14-days watering.

It can be concluded that frequent irrigation and organic fertilisation are highly needed and recommended for high yield production of muskmelon on Gezira Vertisols.

Keywords: Irrigation, muskmelon, organic fertiliser, Sudan, Vertisols

Phenological Responses of Rice Genotypes to Varying Thermal Environments in Nepal

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The rice-wheat crop production system in Nepal includes a pronounced Dry-to-Wet-Transition (DWT) fallow period between the harvest of wheat and the transplanting of rice. Early rains during this fallow period cause large amounts of soil N to be lost if the system is improperly managed. To exploit nutrient and water availability, this transition period can either be shortened, allowing a third crop to be grown, or extended to increase the time for rice production, by changing the planting date of the rice. Shifting the planting date in the system requires rice genotypes adapted to the new growing environment. Crop duration is influenced by plant development, which is known to be influenced by the photo-thermal environment. This study focused on deriving photo-thermal constants for phenologically not characterised rice cultivars and on applying the phenological model RIDEV to design cropping calendar options. Crop duration of tested genotypes was determined for dates different from the recommended one and the risk of yield losses due to cold sterility was estimated by simulation. 32 rice genotypes were planted at 8 dates in 15-day intervals starting 27th April 2004 at the experimental field of the Regional Agriculture Research Station, Lumle, Nepal.

Duration to flowering was shortest for planting dates in late May and early June. Chilling tolerant cultivars showed increasingly shorter thermal duration to flowering with advancing planting dates. Simulation of flowering dates with RIDEV yielded correct results only for the early planting dates. For later planting dates simulated flowering dates showed an increasing deviation from the observed. In most of the cultivars, T_{min} below 18°C during this stages caused near-total spikelet sterility and a specific delay in flowering. However, the chilling tolerant cultivars Chomrong and Machhapuchre-3 showed below 40% spikelet sterility even at $T_{min} = 15^{\circ}\text{C}$. The results of the field trial and the simulations with RIDEV imply that early planting of rice is a promising cropping calendar option to manage DWT fallow period for Nepal's mountainous rice production systems. The effect of early rice cultivation on the nutrient dynamics of the soil should be addressed in future research.

Keywords: Cold sterility, cropping calendars, high altitude cropping, modelling, rice-wheat-system

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Influence of Root Zone Bacteria on Root Iron Plaque Formation in Rice Subjected to Iron Toxicity

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Iron is essential to both energy processes and growth in plants. It exists either as ferric iron (Fe³⁺), which precipitates in alkaline and oxidising soil conditions being unavailable to plants, or plant available as ferrous iron (Fe²⁺) under reducing or acidic conditions. Reduced, anaerobic conditions are predominant in lowland rice cultivation, in combination with high soil Fe concentrations causing iron toxicity via an excess of ferrous iron present in the soil due to the activity of rhizosphere microorganisms.. As oxidised polyphenols accumulate in the plant tissue, leaves turn orange in colour (bronzing) and brown spots appear on the leaves.

Some bacteria of the genus *Bacillus* that associate with roots, reduce the effects of abiotic stresses. Those bacteria, that can form endospores under unfavourable environmental conditions, have been shown to enhance growth in rice during drought periods. However, little is known about how they affect rice responses to iron toxicity.

Earlier work showed that, from 6 lowland rice varieties differing in iron toxicity tolerance, which were inoculated with 4 bacillus strains (*B. megaterium*, *B. pumilus*, and two isolates of *Bacillus* sp.), 3 of the strains helped mitigate leaf Fe toxicity symptoms. However, genotypes differed in their responses to bacteria/Fe toxicity treatments. One of the main differences seemed to be in the formation of root Fe plaque.

Presently, a new set of experiments is being run to quantify the effects of bacteria present in the root zone on both Fe plaque formation on the roots and on total uptake of Fe to the rice shoot. For this 2 concentrations of iron are applied (0 and 1000 ppm) to 6 lowland rice varieties, inoculated with the bacteria named above. After 4 weeks of growth, one week of inoculation and 1 week of Fe treatment, Fe plaque formation, Fe uptake and distribution, dry matter and Fe toxicity symptoms will be determined. The study will clarify the influence of the different bacteria on root Fe plaque formation allowing further detailed studies on the mechanisms of bacterial effects in the root zone of rice subjected to abiotic, toxicity stress conditions.

Keywords: Abiotic stresses, *Bacillus* sp., iron toxicity tolerance, iron uptake, lowland rice

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Root Iron Plaque Formation as Resistance Mechanism to Iron Toxicity in Lowland Rice

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Iron toxicity is one of the most important abiotic stresses limiting rice production in lowland systems. Fe toxicity during the seedling stage widely affects the yield of lowland rice in the Tropics. The most efficient way to address Fe toxicity is via resistant genotypes. To date screening tools for Fe-toxicity tolerance in rice are based on leaf symptoms and yield, but not on actual resistance mechanisms such as exclusion or tolerance. Thus, cultivars that reportedly showed Fe(II) tolerance frequently succumb to iron toxicity. Recently we developed a mechanistic early screening method that allows the investigation of actual tolerance mechanisms. However, the rice roots are not accessible in this screening method and it is not possible to identify the Fe exclusion potential or retention power of rice roots. The aim of this research was to adapt this screening tool in a controlled growing environment that allows accessing the rice roots.

Rice seedlings were hydroponically grown in PVC boxes for 4 weeks and then subjected to three Fe treatments (0, 1000 and 1500 mg L⁻¹ Fe(II) applied as FeSO₄). Nitrogen gas was infiltrated to the cultural solution through porous stones to provide anoxic conditions. After 3 days stress exposure the rice seedlings were scored for iron toxicity symptoms and, root Fe plaque, iron uptake and partitioning within plant tissues were determined. The amount of Fe formed as plaque at the root surface was approximately three times higher in all tested genotypes than the tissue-Fe concentrations of the rice cultivars. Genotypes differed significantly in the amount of Fe precipitated on the roots under low external Fe concentration and in the ratio between Fe taken up into the root and Fe formed as root plaque. The results indicate that the oxidation power of rice root plays an important role in genotypic resistance to Fe-toxicity as an avoidance mechanism and thus needs to be assessed in screening systems that evaluate rice resistance to Fe toxicity. Further studies to elucidate the mechanisms of root Fe plaque formation are ongoing.

Keywords: Iron uptake, leaf symptoms, *Oryza sativa*, oxidation power, rice

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Field Validation of a Quick Screening Method for Iron Toxicity in Lowland Rice

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Iron toxicity is one of the most important abiotic stresses in lowland rice constraining production in many rice production systems worldwide.

In flooded soils high concentrations of reduced iron lead to excessive Fe uptake by the roots and its subsequent transport in to sensitive leaf tissues. The typical symptom of iron toxicity damage is a copper colouring of the leaves also called leaf bronzing. Particularly in early growth stages iron toxicity leads to severe yield reductions. One possible strategy to avoid yield losses due to iron toxicity is the use of resistant genotypes. Genotypes need to be targeted to the growing environment as the severity of iron toxicity not only depends on the resistance level of the genotype but is also strongly influenced by environmental conditions.

To date, selection tools for resistance to iron toxicity are based on leaf symptoms and yield reductions, which are not necessarily causally related.

Earlier work has shown, that includer / excluder strategies in rice can be identified and selected for, however, those methods have been tested only under controlled conditions so far. By those selection methods, tolerant genotypes (including Fe in the tissue without expressing bronzing symptoms), as well as resistant genotypes (excluding Fe as iron oxides on the root surface) have been identified.

In this study 15 local genotypes have been tested for mechanisms of iron toxicity resistance based on the screening techniques developed earlier in a hydroponic greenhouse experiment and a field trial. The aim was to compare the mechanistic results from the greenhouse screening to the results obtained in the field trial and thus validate the screening tool for transferability to field conditions.

Under both conditions leaf symptom scoring and visual assessment of the plant was conducted in the early vegetative stage followed by destructive sampling and analysis of Fe contents in leaves and stems. At the moment the sample analyses are ongoing. Results will be presented and the potentials and risks of a transfer of the screening method to field conditions will be discussed.

Keywords: Hydroponics, Iron toxic soils, *Oryza sativa*, resistance mechanisms, Viet Nam

Evaluation of Drought Tolerance in Some Rainfed Upland Rice Cultivars

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A large portion of the world's poor farm in rainfed systems where the water supply is unpredictable and droughts are common. Erratic rainfall distribution is the most limiting factor of growing upland rice in India. Genetic improvement of drought tolerance in crop plants needs identification of relevant physiological stress tolerance mechanisms as selection criteria. We compared eight short duration upland rice cultivars using the Fischer and Maurer drought susceptibility index. Field experiments were conducted for five years (1996–2000) in the upland plots of the Agricultural Experimental Farm of the Indian Statistical Institute in Giridih, Jharkhand. Seven cultivars were obtained from the Central Upland Rainfed Rice research station in Hazaribagh (RR-167–982, Kalinga–3, RR-151–3, RR-55–1, RR-50–5, RR-2–6, Birsa-101) and one was locally grown (Brown Gora). Cultivars were grown in a complete randomised block design with 3 replications and each plot size about 30 m².

Highest annual rainfall was recorded in 1997 with 1203 mm, while the lowest amount of rainfall was observed in 2000 with 633 mm. Number of days with rainfall ranged from 35 days in 2000 to 49 days in 1997 and 1999. Based on those climate data we considered 2000 as the only drought year. All cultivars yielded lowest in 2000 while maxim yield could be obtained in years were annual rainfall was high. The drought stress susceptibility index of the cultivars indicated that Brown Gora, Birsa-101, RR-151–3, RR-167–982, RR-50–5, and Kalinga–3 were relatively drought tolerant. In contrast RR-2–6 and RR-51–1 were drought susceptible. The results indicate highest drought tolerance levels in the traditionally grown Brown Gora ($S = 0.38$). However, the best variety with respect to yield in both environments (stress and no-stress conditions) indicated RR-167–982 as the best cultivar for the upland conditions.

In other experiments we could show, that the nitrogen status of the soil is closely related to the moisture regime in the soil. The lower the soil moisture content, the lower the nitrogen use efficiency in the plants. In general we conclude that in areas of uncertain moisture supply, nitrogen application rate should be reduced from that normally used for irrigated rice.

Keywords: Drought tolerance, India, nitrogen content, soil moisture, upland rice

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Genotypic and Differential Responses of Growth and Yield of Some Maize (*Zea mays* L.) Genotypes to Drought Stress

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Fifteen genotypes of maize (*Zea mays* L.) were evaluated at two locations in Sudan (Khartoum and Wad Medani) during the season 2003/04, to estimate the genetic variability and performance for yield and some vegetative characters under drought at vegetative and reproductive growth stages. Three water treatments were applied, namely; well-watering, drought during vegetative stage only, and drought during reproductive stage only. Phenotypic and genotypic variances, genotypic coefficient of variation, heritability, genetic advance and phenotypic correlation between yield and some vegetative traits were estimated. Significant differences among genotypes were found for most of the traits studied, except days till 95 % anthesis, stem diameter (45 days), leaf area index (30 and 60 days), and number of leaves/plant (45 days). The genotypes showed differential yield response to drought stress. High yield (kg ha^{-1}) was exhibited by genotype PR-2 when drought stress was during vegetative stage, and by genotype Z-2 when it was during reproductive stage. However, the genotype M-45 exhibited considerable higher yield when it was exposed to drought at both vegetative and reproductive stage. The effect of drought on genotypes was significant for days till 25 % silking, plant height and grain yield (kg ha^{-1}) at Wad Medani. High genotypic coefficient of variation, heritability and genetic advance were exhibited by plant height. Grain yield (kg ha^{-1}) was significantly and positively correlated with plant height, stem diameter (45 days), leaf area index and number of leaves/plant (60 days). However, grain yield showed a significant and negative association with days to 50 % and 95 % silking. It could be concluded that, genotypes have differential yield response to drought stress and accordingly the genotype M-45 could be used for further improvement of drought tolerance in maize. Based on their positive association with yield, the characters plant height, stem diameter and number of leaves/plant would be the best selection criteria for maize improvement.

Keywords: Genotypic correlation, drought stress, genotypic variance, heritability, reproductive stage, selection criteria, vegetative stage, *Zea mays*, maize cultivars

Maize Yield Response to Mulch, Burning and Insecticide Application on an Ultisol

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Maize is gaining importance in the humid forest zone due to its early maturity, low labour input and ease of marketing. However, farmers face problems of supplying sufficient N to high density maize sole crops. Mulches from species with high N content can overcome this problem at low capital cost, yet retaining large quantities of mulch has been shown to reduce plant density. One reason could be damage to germinating seeds by insect or other pests hiding in the mulch layer. This study evaluated the yield response of maize to mulch application versus bare soil and the consequences of insecticide application to protect seedlings. Maize was planted at 20 plants m⁻² to determine germination rates and thinned to 6.67 m⁻² in late May and late September. The trial was a 2 factorial design with 6 replicates; 1st factor was insecticide application versus nil, 2nd factor was biomass management at three levels: Mulch mixed of *Senna spectabilis* (75 %), *Chromolaena odorata* (20 %) and *Calliandra calothyrsus* (5 %) leaves was applied at 10 Mg ha⁻¹ and either retained or burned versus bare soil. Mulch application was only in the 1st season.

Insecticide application had no effect on germination rate 93 % and 25 % in the 1st and 2nd season, respectively. Plant density at harvest was unaffected by insecticide and biomass management in both seasons. Cob density was highest in mulch retained followed by mulch burned. Marketable cobs were only produced when mulch was applied. On bare soil virtually no yield was attained (55 kg ha⁻¹), when mulch had been burned 269 kg ha⁻¹ and when mulch had been retained 795 kg ha⁻¹ of grain were harvested. The difference between mulch retained and the other treatments was significant at $p < 0.002$. In the second season, bare soil and previous mulch burned produced 255 kg ha⁻¹ grain while mulch retained produced 606 kg ha⁻¹ ($p < 0.002$). Mulch application when burned had thus no yield effect, while a single application of retained mulch increased yield in the following 2nd season.

Keywords: Cameroon, cob production, mulch, insect damage, maize grain yield, ultisol

Productivity of Three Maize Cultivars as Affected by Organomineral Fertiliser and Arbuscular Mycorrhizal Fungi under Greenhouse Conditions

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Soil fertility is one of the major constraints to crop production in the tropics particularly for short-term arable crops such as maize. Varieties are being developed to increase yield to meet the nutritional requirement of the growing population. Can there be reasonable growth of these varieties in nutrient depleted soils? Can the symbiotic organism such as arbuscular mycorrhizae (AM) fungi and organomineral fertiliser (OMF) assist in enhancing the yield of these crops particularly under controlled conditions? Hence, a factorial experiment, completely randomised design replicated three times was conducted on nutrient depleted soil for 12 weeks using two levels of OMF (with and without) and AM fungi (*Glomus mossae*) on three cultivars of early maturing maize under greenhouse conditions, in 10 litre pots. The response of the vegetative parameters at the early growth stage at 2 weeks after sowing (WAS) showed that there was competition between AM fungi and the maize cultivars over the available nutrients. However, cultivar ACR9931-DMRSR increased significantly in height at 5, 7 and 10 WAS, but not significantly increased ($P < 0.05$) compared to cultivar ACR9922. Similar trend was followed by the same cultivars in terms of the maize stem girth; especially where OMF alone or combined with AM fungi were applied. Maize leaf length at 5, 7 and 10 WAS showed similar trend with cultivars ACR 9931 and ACR9928-DMRSR being significantly ($P < 0.05$) increased at 7 WAS compared to cultivar ACR9922-DMRSR which not significantly increased. At harvest, dry matter accumulation and grain yield followed a similar trend to those observed under height when OMF and AM fungi were applied and when OMF was applied without mycorrhizal. It is therefore possible to enhance the growth and yield of maize varieties through the combination of these technologies in nutrient depleted soils.

Keywords: Arbuscular mycorrhiza, maize cultivars, organomineral fertiliser, soil fertility

Growth and Productivity of Maize Cultivated in No-Tillage in Succession of Different Cover Crops

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The use of cover plants, especially leguminous, can improve the fertility of the soil by the nutrients cycling and adds N by symbiotic fixation. In the organic system of production is not allowed the use of fertiliser with high solubility. Thus the use of agricultural systems with leguminous species is an efficient strategy in promoting the accumulation of total N in the superficial layer of the soil, for the maize nutrition. This work was carried out with the objective of evaluating, through the growth analysis, the effects of cover plants on the development of maize (*Zea mays* L.) cultivars AG 1051, under no-tillage, in organic system of production. This study was conducted in typical dystrophic Red Latosol (Oxisol) located at Experimental Station of Embrapa Rice and Beans, in Santo Antônio de Goiás, Goiás State, Brazil. The experiment was carried out in a randomised block design, using five treatments with four replications. The treatments were represented by cover plants: velvet bean (*Mucuna aterrima*), Dwarf pigeon pea (*Cajanus cajan*), Sun hemp (*Crotalaria juncea*), Sorghum (*Sorghum technicum*), and fallow with spontaneous vegetation. For evaluating leaf area and dry matter production, ten samples were collected at seven days intervals, randomly taking three plants, replicated two times. The growth analysis showed for the variables leaf area and dry matter production significant differences for those maize plants cultivated in succession to the leguminous, especially velvet bean and sun hemp, and for those cultivated in succession to the spontaneous vegetation and sorghum. The medium productivity of ears of maize without husk went larger for the system of succession sun hemp-maize (11.534 kg ha⁻¹).

Keywords: Growth analysis, leaf area index, leguminous, *Zea mays*, maize

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Tillage and Fertiliser Effects on Sole Maize Cropping in a Degraded Nigerian Alfisol

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The choice of appropriate tillage system is crucial for sustainable farming in tropical ecosystems. With high levels of soil erosion and nutrient leaching in the tropics, reducing tillage and good fertiliser management becomes an attractive option to consider for environmental conservation. A field study on a degraded alfisol in Ibadan (south-western Nigeria), was conducted to determine the effects of four tillage systems (TS): (plow + harrow, plow, chisel + harrow and chisel) and three fertiliser NPK 15:15:15 rates: (0, 40 and 80 kg ha⁻¹) on maize grain and stover yields. Significant treatment effects were found in root length, grain yield and hundred seed weight. Maize under plow + harrow TS had the highest mean root length (23.1 cm), which was 38 % and 28 % significantly higher than chiseling and chiseling + harrowing. Root length decreased with increasing fertiliser rates in all systems (except chisel + harrow). Grain yield significantly increased only with increasing fertiliser rates. A grain yield of 1.4 t ha⁻¹ was obtained when 0 kg NPK ha⁻¹ was combined with plow + harrow TS. Plow alone had grain yields of 1.9 and 2.0 t ha⁻¹ with 40 and 80 kg NPK kg ha⁻¹ fertiliser rates, respectively. These grain yields were not significantly different from those under plow + harrow TS at the same fertiliser rates. Only hundred seed weight significantly responded to TS by fertiliser interactions. From the results, plowing TS when combined with 40 kg NPK ha⁻¹ was sufficient for maize production on degraded alfisols

Keywords: Alfisol, degraded, fertiliser, maize, tillage

Water use: current situation and perspectives

Invited Paper	461
PAY DRECHSEL, BERNARD KERAITA, PHILIP AMOAH: Urbanisation and Wastewater Irrigation in Developing Countries: Applied Research on Food Safety in the Rural-Urban Interface	461
Oral Presentations	462
HEINZ-PETER WOLFF, MORDECHAI SHECHTER, THAMEEN HIJAWI, AMER Z. SALMAN: Forecasting Social and Economic Impacts from Climate Change on Farming Systems in Riparian Countries of the Jordan River – A Combined Model-based Approach	462
MANJUNATHA ARAHALLI VENKATARONAPPA, NAGARAJ NAREPPA, P.G. CHENGAPPA, CHANDRAKANTH MYSORE: Groundwater Depletion and Drip Irrigation as a Coping Strategy in Hard Rock Areas of Peninsular India	463
Posters	464
FRANCISCO MARCUZZO, EDSON WENDLAND, LIJALEM ZERAY: Mathematical Optimisation of Irrigation Pipes	464
JOHNSON FASINMINRIN, PHILIP OGUNTUNDE: Modelling the Soil Water - Yield of <i>Amaranthus cruentus</i> Grown under Drip and Sprinkler Irrigation Systems	465
NICOLA MARTIN, IRIT EGUAVOEN, JEAN-PIERRE SANDWIDI, ALEXANDRE SESSOUMA: Hydrogeological and Socio-Legal Aspects of Groundwater for Household Provision in the Volta River Basin	466
AARON LEOPOLD: Governing the (Ab)Use of a Dwindling Resource: The Water of Hyderabad, India	467
KAMORU ADENIRAN: Pollution Potentials of Cassava-Waste Effluent	468
ABDALLA ELHAGWA, CHRISTIAN RICHTER: Characterisation and Evaluation of Irrigable Bare Lands of the White Nile Region, Sudan	469

ISAAC AIYELAAGBE, OLUWASEYI ORODELE:
Leaf Gas Exchange and Growth Response of Juvenile 'Valencia' Orange to Dry Season Irrigation in Southwestern Nigeria 470

ANDREAS DISTEL, CARSTEN MAROHN, GERD DERCON, FAH-MUDDIN AGUS, LAXMAN JOSHI, MEINE VAN NOORDWIJK, UWE MEYER, GEORG CADISCH:
Assessing Temporal Dynamics of Groundwater and Soil Salinity and Impact on the Green Infrastructure after the Tsunami Event in Aceh, Indonesia 471

KRISHNA BAHADUR K. C., WERNER DOPPLER, JIRAWAN KITCHAICHAROEN:
Impact of Water Resources Development and Irrigation on Rural Livelihood: A Case Study from Phayao Province Northern Thailand 472

CHRISTINE ZÖLLMER, MELVIN LIPPE, NGUYEN VAN DUNG, TRAN DUC VIEN, THOMAS HILGER, GEORG CADISCH:
Development of a Simple PCRaster-Based Model for Rainfall-Runoff Assessment in the Northern Mountainous Region of Viet Nam 473

FITE GETANEH, ABDENNA DERESSA, WAKENE NEGASSA CHEWAKA:
Influence of Irrigation on Soil Chemical Properties 474

MOHAMMAD AZIZUR RAHMAN, JACKSON ROEHRIG:
Hydrological and Hydro-Chemical Investigation for Sustainable Agricultural Management in Bangladesh 475

ABDELMAGID ELMOBARAK, MAHASIN ALI MOHAMED, MOHAMED AHMED KHAIR, ABDELHADI ABDELWAHAB, CHRISTIAN RICHTER:
Effects of Irrigation Interval, Sowing Method and Nitrogen Application on Forage and Grain Yield of Barley in the Gezira Scheme, Sudan 476

AHMED ABU SHABAN, WERNER DOPPLER, HEINZ-PETER WOLFF:
Socio-Economic Assessment of Treated Wastewater Irrigation in Northern Gaza 477

ELGILANY A. AHMED, HAMID H.M. FAKI, HASHIM A. ELOBEID:
Assessment of On-Farm Water Use Efficiency in the Public Irrigated Schemes in the River Nile State of Sudan 478

Urbanisation and Wastewater Irrigation in Developing Countries: Applied Research on Food Safety in the Rural-Urban Interface

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In the discussion of current and future water challenges, the phenomenon of Urbanization is not only challenging cross-sectoral water allocations but has in particular in developing countries a strong water quality component. In most urban centers in Africa, urbanization has outpaced sanitation infrastructure by decades, and wastewater from domestic and industrial sources is polluting urban and peri-urban water bodies. Efforts to increase wastewater treatment will remain a patchwork also in the mid term.

This situation has a significant impact on the production of e.g. irrigated high value vegetables which are preferably grown in city (market) vicinity. In the case of - for example - Accra, Ghana, about 200,000 urban dwellers eat every day in street restaurants fast food with vegetables produced with this kind of diluted wastewater.

As Africa's industrial development is still limited, the largest problem are pathogens. Applied research is needed to improve food safety and reduce public health risks in a situation where wastewater treatment is no option. The new global WHO-FAO-UNEP "Guidelines for the Safe Use of Wastewater, Excreta and Greywater in Agriculture" offer an interesting approach but most of the recommendations have a limited application potential. The presentation will illustrate the situation with a 3 min video-clip and give examples from research along the farm-to-fork contamination pathway to find regional solutions, address knowledge gaps and highlight remaining challenges for applied research.

The examples derive from the work supported by the International Water Management Institute (IWMI). IWMI is one of the 15 centers of the Consultative Group on International Agricultural Research (CGIAR). It established in 2005 a research division on "Agriculture, Water and Cities" to focus on the global challenges of urbanization, urban food supply, food safety and cross-sectoral water allocation and competition in the rural-urban continuum. Current projects are located in West and East Africa and South Asia. Key partners are national institution and universities, the WHO and FAO.

Keywords: Greywater, IWMI, Ghana, water use

Forecasting Social and Economic Impacts from Climate Change on Farming Systems in Riparian Countries of the Jordan River – A Combined Model-based Approach

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Estimations from research on Global Climate Change anticipate significant shifts in precipitation and temperatures in the Jordan River watershed. The consequences will unfold in an area with a high variety of institutional, social and economic conditions, which makes it an exemplary case for the need of combined modelling approaches for prognoses on socio-economic impacts. A team of German, Israeli, Jordanian and Palestinian scientist started such a combined approach in 2005 under the umbrella of the GLOWA Jordan River Project, funded by the BMBF. Thorough analyses of the situation of land and water use led to the choice of specific models for the three concerned countries, but revealed simultaneously potential “masking effects” by changes in the institutional and managerial frame conditions. The combined approach takes these effects into account by modelling on two tracks. The first track considers land and water as national production factors and determines the optimal use of these resources by maximising the added value. Modelling on this track for Israel, which diverts its current shares of the Jordan River waters via the National water carrier and distributes it for additional irrigation in most regions of its territory, relies on a production function model. Modelling for Jordan is based on a regional LP model that is more adequate for the use of water for fully irrigated agriculture. The second track focuses on farming systems and enterprises and tries to predict the best decisions of farmers with regard to their economic success. A Ricardian model serves this purpose on the Israeli side, while LP-based farm-household models are more suitable for impact analyses in Palestinian and Jordanian farming systems. First results from modelling on track 1 show, that improvements in the institutional set-up and management of water still have a leeway that may probably equalise expected impacts from Climate Change. Results from track 2, however, indicate that both, impacts from Climate Change as well as changes in institutions and management, will lead to a clear distinction between winners and losers among the highly heterogeneous farming systems in the study area.

Keywords: Agriculture, climate change, farming system, Jordan Valley, modelling

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Groundwater Depletion and Drip Irrigation as a Coping Strategy in Hard Rock Areas of Peninsular India

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Groundwater irrigation has been instrumental in achieving food security in the Indian economy. The investment in groundwater development and use has been increasing manifold since four decades. Currently groundwater resource in hard-rock areas is facing threat of overexploitation resulting in secular decline in water table. This has severely impaired the groundwater-based agriculture in the semiarid areas, where there is no assured source of perennial irrigation. Thus groundwater crisis has been persisting in different scale and affecting sustainability of groundwater based agriculture is at stake. This study pertains to hard rock area in eastern Dry Zone of Karnataka of India with groundwater as only source of irrigation. The village is located in proximity to Bangalore city and obviously influenced by urbanisation. The cropping pattern includes cereals, high value vegetables and mulberry a host plant for silkworms. Farmers follow intensive and improved agricultural practices, cultivating new varieties and adopting latest technologies. The intensification of agriculture in response to a strong urban market demand poses threat to groundwater overdraft. This has pushed the groundwater economy to a critical stage in the region. As a response to physical and economic scarcity of groundwater, farmers have been resorting to water use efficient irrigation technologies. The results indicate that, under drip irrigation system, in the case of tomato crop water can be saved to the tune of 23.5 percent over furrow irrigation. Similarly, for potato crop the savings in water was around 42 percent, while in the case of mulberry, it was around 47 percent. Under drip irrigation, the productivity differential is around 20 to 22 percent over furrow irrigation. The water use efficiency in terms of incremental output per acre inch of water used due to drip irrigation is very high in the case of mulberry compared to vegetable crops. The incremental returns accrued due to drip irrigation far exceeded the amortized cost of drip in both vegetables and mulberry. Similarly, the economic efficiency in terms of incremental returns per acre-inch of water is also very high. Drip irrigation induces both physical and economic efficiency exerts, and much lower pressure on groundwater, than at present.

Keywords: Drip irrigation, efficiency, groundwater, India

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Mathematical Optimisation of Irrigation Pipes

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In order to secure the quality of on-farm food production, it is necessary to guarantee continuous water supply to the plants. However, this is difficult to be achieved due to the expensive irrigation systems' cost. Hence, high irrigation system installation cost is the biggest limitation, especially in the case of long pipe systems. Consequently, the decision making process should consider different combinations of pipe lengths and pipe diameters for the design of irrigation systems. Based on experience, the design engineer, usually carries-out countless trial-and-error computations to come up with a minimum acceptable head loss based on pre-established length and diameter combinations. This process is found to be very difficult since designers do not make the decisions on mathematically optimised way. Pipe design based on mathematical linear programming optimisation is the best solution to solve this kind problem. Accordingly, a mathematical linear programming based spreadsheet was developed for the design of pipe systems. The design pipe combines four diameters of 150, 125, 100 and 75 mm, which are commercially available in the Brazilian pipe markets. The minimised objective function was the pipe cost, constrained by the commercially available diameters, the admissible head loss and the maximal water velocity in the pipe. For the admissible head loss determination, six different head loss equations were tested. These are the Hazen-Williams, Manning, Scobey, Swamee-Jain, Flamant and Darcy-Weisbach equations. The lowest cost of US\$ 610.59 for a 300 m pipe was found with the Scobey head loss equation, whereas the highest cost of US\$ 779.71 was observed using the Darcy-Weisbach head loss equation. The difference of 28 % between the lowest and the highest costs indicates that huge discrepancies can be observed, depending on the head loss equation selected by the designer.

Keywords: Food production, head loss, hydraulic, irrigation, linear programming, pipe diameters

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Modelling the Soil Water - Yield of *Amaranthus cruentus* Grown under Drip and Sprinkler Irrigation Systems

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Spinach (*Amaranthus cruentus*) is the most widely cultivated leafy vegetable of the humid tropics because of its nutritional and medicinal values. The aim of the study was to use soil moisture estimates in modelling the yield of *Amaranthus cruentus* grown under two irrigation systems (sprinkler and drip systems) and three (3) water stress levels (severe stress, medium stress and no stress) as determined by tensiometer threshold values. Soil moisture content at depths 10, 20, 30, 40, and 50 cm were monitored weekly with the aid of soil moisture metre (Echo Probe). Soil moisture calibration curve showed high correlation coefficients ($R^2 = 0.87$, $P < 0.05$) between the moisture stored in the soil and the moisture tension within the soil layers. It was generally observed that the moisture tension within the soil layers represents adequately well the wetness of the soil. A high correlation coefficient ($R^2 = 0.94$) was observed between model output and the measured value. The difference in soil moisture tension at the three soil depths considered is highly significant at P ($\alpha = 0.05$) level. Non-linear parametric model of the form $\alpha_1 * m^2 + \alpha_2 * m - \alpha_3$ was formulated for the simulation of soil moisture levels at different tensiometer readings. The dependent variables of model are the *Amaranthus cruentus* yield and the independent variables are the terminal soil moisture levels. Both linear and non-linear regressions were used to simulate the yield of the crop. The yield of *Amaranthus cruentus* was highly correlated ($R^2 = 0.74$, $P < 0.05$) to available soil moisture in the sprinkler plot. However, the coefficient of correlation of yield to soil moisture was higher ($R^2 = 0.79$, $p < 0.05$).

Keywords: Drip, irrigation, soil moisture, sprinkler, yield

Hydrogeological and Socio-Legal Aspects of Groundwater for Household Provision in the Volta River Basin

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In the semi-arid North of the Volta River basin the main source of water supply to rural households is groundwater tapped by hand dug wells and boreholes. Household water security depends on the hydrogeological and climatic conditions determining groundwater availability, but also on the way access and use of the resource are regulated. This study discusses groundwater availability and socio-legal aspects of household water use in two small sub-catchments, the Atankwidi catchment in northern Ghana and the Kompienga catchment in Burkina Faso, based on the following questions:

(1) How sustainable is the use of available groundwater resources?

(2) How do socio-legal factors affect household water security?

Hydrogeological assessment suggests that there is still a large potential to increase extraction of groundwater as a safe source for drinking. However, household water security is not yet reached in all communities, because access to groundwater is limited by institutional conditions. Although the natural and socio-cultural framework is very similar in both catchments, national drinking water programmes in the two countries regulate resource planning and household water provision differently. In Ghana, a number of institutional changes resulted from the implementation of the National Community Water and Sanitation Program. This was sometimes in conflict with previous local water right regimes and reduced the flexibility of communities to choose their water source. In Burkina Faso, the acquisition of boreholes and their access definition were highly politicized and shaped by local power struggles. The paper traces how these different conditions affect household water security in the two catchments.

Keywords: Groundwater, household supply, Volta River basin, water security

Governing the (Ab)Use of a Dwindling Resource: The Water of Hyderabad, India

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Departing from the traditional rural focus of Tropentag, this presentation/poster aims to explore an urban phenomenon, the disappearance of water in Hyderabad, India—a megacity-to-be. The increasing importance of cities in the global economy has turned Hyderabad into a migratory magnet: the current population of over six million is expected to more than double in the next 15 years. Already however, the rapid urbanisation to date has forced drastic land use changes in and around the city, which have culminated in a crisis stage water shortage today.

The foci of my contribution will be threefold: first, to discuss Hyderabad's urban encroachment of water sources (filling in/drying out/and polluting to extinction) and rural outlying areas (primarily constructing on and polluting farmland) as primary causes of this problem— which, taken together, amount to the very opposite of land use diversity. Secondly, the resulting social (primarily health and gender issues) and environmental impacts (loss of biodiversity, soil erosion, heat waves, etc.) will be explored. The final section will be an elaboration of how improved communication, interaction and respect between the principal actors involved in Hyderabad's water issues have the potential to drastically benefit the city by lowering per capita water consumption and revitalizing the sinking water table.

Taking a very multidisciplinary approach, this analysis is one which draws upon literature from a variety of different fields including: governance theory, urban poverty, Indian cultural and governmental history, environmental management, urban planning, participatory democracy, and citizen engagement studies. Of particular importance will be the idea of participatory governance, which will be used throughout my analysis to tease out root causes as well as non-tech and low-tech solutions to the immense water issues facing Hyderabad today.

Precisely because I conclude that Hyderabad's current water crisis is largely the result of political mismanagement and rent seeking activities, I believe that these mostly low public cost solutions, revolving around a more equitable distribution of decision making and higher levels of responsibility amongst stakeholding members of society, can significantly slow down and hopefully reduce the severity of this problem in the future.

Keywords: Encroachment, governance, resource depletion, stakeholder participation, water scarcity

Pollution Potentials of Cassava-Waste Effluent

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An investigation was carried out on the effects of cassava waste effluent on the pollution of adjacent surface and underground water (well) water sources. Effluents were collected from six cassava processing sites located at Tanke, Amilegbe, Lajonrin, Oyun, Agbo-Oba and Oko-Erin areas within Ilorin metropolis, Kwara State, Nigeria, during the 2004 Rainy Season (August to October 2004) and the 2004/2005 Dry Season (November 2004 to March 2005). Physical and chemical properties of the effluent were compared with those recommended by the World Health Organisation (WHO, 1993) standards for drinking water. Results show that some parameters like colour, turbidity, pH and cyanide exceeded WHO (1993) limits. For colour, the least value of 15.5 mg l⁻¹ obtained was higher than the limit of 15.0 mg l⁻¹ set by WHO (1993) standards, while for turbidity the range of values obtained (5.0 to 6.9 NTU) exceeded 5.0 NTU recommended by WHO (1993) standards. The values of pH were found to be between 4.2 to 6.4 (highly acidic) which is far below 6.5 to 8.5 recommended by WHO (1993). The cyanide content ranged from 0.1 to 2.8 mg l⁻¹ was also above 0.1 mg l⁻¹ set by WHO (1993). The pollution potentials of cassava waste effluent were found to be higher during the dry season than during the rainy season. Lower values were recorded for underground (well) samples than for surface samples because of the effect of underground seepage. The study shows that cassava waste effluent, if untreated, poses a great danger as far as the pollution of surface and underground water sources is concerned in the country. The Federal Government through the Federal Environmental Agency (FEPA) ensured that cassava waste effluent is properly treated before they are released to our water bodies.

Keywords: Cassava waste effluent, physical and chemical properties, pollution potentials, surface water, underground, well

Characterisation and Evaluation of Irrigable Bare Lands of the White Nile Region, Sudan

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A total area of about 65,000 ha of the White Nile Region of Sudan was characterised and evaluated whether it can be irrigated from the White Nile and used for agricultural production of these poor areas. Therefore, 10 profiles and more than 5,000 soil samples were analysed to study different soil characteristics, especially the salinity and sodicity distribution in the area. Six different soil types were identified as to their variability in their landscape position, soil texture, soil pH and vertisolic characteristics. Four of these six soil types were classified as Vertisols and two as Aridisols.

The predominant limitations for irrigated agriculture were mostly related to their high content of smectitic clays (vertisolic limitations), to a high content of water soluble salts, and to a too high content of exchangeable sodium. In more than 50 % of the area soluble salts were concentrated mainly in the top 30 cm of the soil profile. The salinity classes were mainly slightly to moderately saline (EC_e 4 to 16 dSm^{-1}). High contents of salts ($EC_e > 16 dSm^{-1}$) were found only in 1 % of the total area and were mostly associated with depressional sites. Slightly to strongly sodic soils (SAR 8 to 38) occupied 30.4 % of the total area in the depth of 0 to 30 cm, and 32.4 % in the deeper soil layers, while strongly sodic soils (SAR > 38) represented 5 % in the depth of 0 to 30 cm.

In general it could be seen that the current land suitability for irrigated agriculture in the White Nile Region of Sudan ranged from 56.1 % of the identified land units as moderately suitable to 43.9 % as marginally suitable.

Keywords: Land evaluation, salinity, sodicity, soil classification, soils of Sudan

Leaf Gas Exchange and Growth Response of Juvenile 'Valencia' Orange to Dry Season Irrigation in Southwestern Nigeria

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In August 2006 at Abeokuta southwestern Nigeria, 18-month old budded seedlings of 'Valencia' sweet orange (*Citrus sinensis* L. Osbeck) on Cleopatra mandarin (*Citrus reticulata*) rootstock were transplanted 3.5 m apart. Between January and April 2007 which corresponded to the dry season, the seedlings were irrigated with 7.5, 30 and 60 l water plant⁻¹ week⁻¹. The aim was to determine if juvenile sweet orange plants responded to dry season irrigation, the critical volume of water for growth and by which mechanism irrigation exerted its influence on vegetative growth. Local farmers do not irrigate their juvenile citrus plants during the dry season. Effects of dry season irrigation on photosynthesis and transpiration were determined using the CIRAS⁻¹ leaf gas exchange metre in the morning (9–10am), afternoon (1–2pm) and evening (5–6pm). Growth was determined using measurements of plant height, number of leaves and leaf area of citrus plants taken at 2-week intervals. Application of 30 l water week⁻¹ enhanced photosynthesis of citrus in the morning, afternoon and evening, while 7.5 and 60 l water week⁻¹ decreased it. Conversely, application of 7.5 l water plant⁻¹ week⁻¹ significantly decreased morning afternoon and evening transpiration while application of 30 or 60 l water plant⁻¹ week⁻¹ enhanced it. Compared with application of 7.5 l water plant⁻¹ week⁻¹, application of 30 l water plant⁻¹ week⁻¹ significantly increased plant height and leaf area but 60 l water plant⁻¹ week⁻¹ decreased it. Effect of irrigation on number of leaves was not significant. Irrigation influenced the growth of citrus by influencing photosynthesis. Irrigation cycles of 7.5 l water plant⁻¹ week⁻¹ induced water stress while 60 l water plant⁻¹ week⁻¹ induced water logging conditions. Water stress and water logging impaired photosynthesis and growth of citrus. Irrigation with 30 l water plant⁻¹ week⁻¹ is considered critical for optimum photosynthesis and vegetative growth of juvenile sweet orange seedlings during the dry season. The application of 30 l water plant⁻¹ week⁻¹ is recommended to citrus growers in southwestern Nigeria

Keywords: Citrus, irrigation, water stress

Assessing Temporal Dynamics of Groundwater and Soil Salinity and Impact on the Green Infrastructure after the Tsunami Event in Aceh, Indonesia

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After the 2004 Tsunami the coastal area of Aceh-Indonesia was flooded up to 5 km land inwards. Losses of lives and infrastructure destruction were the major problems people faced. However, land subsidence due to the preceding earthquake and flooding also led to saltwater intrusion and mud deposits. In many areas, groundwater salinisation was only temporary, but long enough to cause damage to salt susceptible crops like rambutan or beans. Nevertheless permanent changes in groundwater quality and level obliged farmers in subsided or deposition areas to change crops or use new varieties. The aim of the study is to determine the impact of saltwater intrusion, in time, on soil and groundwater quality, as well to assess and to understand consequences for different tree crops. The study focuses on ten existing transects perpendicular to the coast of Aceh Barat. For these transects, EC, pH, several cations and anions in the groundwater have been analysed in 2006. These measurements are currently being repeated and datasets will be complemented with secondary data for shallow wells shortly after the tsunami. In addition, soil data and tree damage will be assessed. Secondary data comprise salt contents in soil and groundwater analysed by the Federal Institute of Geosciences in Hannover, the Indonesian Soil Research Institute and local Non-Governmental-Organisations. Own measurements include EC, pH, Na⁺, Mg²⁺, Ca²⁺ in soil and water samples. Sodium adsorption ratio and exchangeable sodium percentage will be determined for soils with high sodium contents. The different datasets collected between 2005 and 2007 will be compiled allowing a more specific assessment on the temporal process of groundwater (de)salinisation. Further, links between saltwater intrusion and tree crop damage shall be elucidated. For the latter purpose, interviews with farmers are conducted to assess the tree crop damage (as % mortality rate, yield depression or leaf shedding). These data are supplement with own field observations. Further results are expected about the salt tolerance of different species. Finally, based on the study, it should be possible to recommend suitable locations and tree species for rebuilding the “green infrastructure” in the area.

Keywords: Indonesia, salinisation, temporal dynamics, tree damage, tsunami

Impact of Water Resources Development and Irrigation on Rural Livelihood: A Case Study from Phayao Province Northern Thailand

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In the mountainous region of Thailand, water is becoming the scarce resource and water related problems are increasing day by day as in other parts of the world. However, farmers still use the traditional water resource management which cannot cope with future organisational and managerial needs. Thus, many water-related myths and expectations in this regards need to be examined such as whether there are possibilities for better development and use of water on the family and regional levels? Evaluation is therefore needed in the context of the investigation of future strategies for better use using the potentiality of modern planning tools and management concepts. Sufficient regional studies in this regards have not yet been carried out. Therefore this research seeks to analyse water resources at the regional and family level through the use of RS/GIS and socio-economic analyses and model in order to see the development of water resources in the past and current situation and to develop future strategies.

Research is based on the methodological concept of integrating socio-economic assessment with biophysical environment. Biophysical indicators will be assessed using RS/GIS technology. Socio-economic conditions of the people will be assessed based on a survey with in-depth interviews with randomly sampled families. Then these data will be linked to the GIS by using each family's and their respective farming fields geographical positioning and further analysis will be carried out.

GPS mapping of sample farming field were carried out and they were compared with the latest quick bird satellite image over the study area. GIS databases including hydrological structures were constructed and possible location for collecting the rain water were mapped. Results from the satellite images assessment show the significant changes in the water resources development from the past to current days. Socio-economic assessment including the characterisation of farm family, farm family level water related issues and overall living standard assessment is going on. After the farm family level assessment results will be linked to the GIS and further spatial level assessment will be carried out.

Keywords: GIS, integration, remote sensing, rural development, socio-economic situation, Thailand, water use

Development of a Simple PCRaster-Based Model for Rainfall-Runoff Assessment in the Northern Mountainous Region of Viet Nam

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Land degradation is a severe problem worldwide, particularly in resource-poor regions of the tropics when non-adapted cropping systems are used. One of these systems is slash and burn agriculture, involving clearing of land for cultivation which has to be fallowed after a short cropping period for three years or more to recover its soil fertility. When population densities increase and the availability of forest areas decreases or the extension in such areas is prohibited, arable land becomes a scarce resource, forcing farmers to prolong their cropping cycles and shorten the fallow periods. This leads to a severe, often irreversible decrease in soil fertility. Furthermore, it can lead to severe soil erosion on hillsides, particularly when associated with deep ploughing. Many studies have been undertaken to identify sustainable land-use options. In contrast to plot level, our understanding of the underlying processes of soil degradation at landscape level, which are often very complex, is limited. A modelling approach may, therefore, help to better understand the impact of new technologies or land-use intensification on land-use and environmental services. The objectives of this study were (i) to develop a simple spatially explicit rainfall and runoff model and (ii) to test its applicability for mountainous regions in Northwest Viet Nam. The model structure is presented, based on an approach developed by Karssenberget al. (1997). It is written in PCRaster, a computer language for construction of iterative spatio-temporal environmental models. The model calculates the runoff which flows down the drain direction of the slope, depending on rainfall and soil cover. Data from the Ban Tat hamlet, located in the Da Bac district of the Hoah Binh province in North Viet Nam were used for model parameterisation and calibration. Model runs based on three scenarios were used to discuss the importance of influencing factors such as vegetation cover, vegetation cycle, and spatial distribution of land-use. Results showed that a long but less dense vegetation cover is more effective to prevent runoff than a dense but short vegetation cover. Furthermore, a row of forest between the cultivated fields significantly reduced runoff amounts, indicating the importance of soil conservation measures.

Keywords: Modelling, PCRaster, rainfall, runoff, swidden agriculture, vegetation cover, Viet Nam

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Influence of Irrigation on Soil Chemical Properties

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The study aimed to investigate the likely changes of soil chemical parameters due to irrigation in the irrigated farms in comparison to the adjoining non irrigated farms. It was conducted on selected irrigation schemes in East Wollega Zone of Oromia National Regional State, Ethiopia in the sub-humid agro-ecology. Six irrigation schemes (both traditional and modern) were selected for sampling. These schemes were selected owing to their age in order to assess the long term effect of irrigation on soil properties. In addition, adjoining non irrigated lands were also sampled from each site for comparison. Composite (25 augers) soil samples were collected from the plow layer (0–20 cm) at each irrigation site while standard laboratory procedures were followed in analysing the soil samples.

The study indicated that irrigation increased the soil pH value in all of the sampled irrigated farms as compared to the adjoining non irrigated farms thereby improving the soil quality from more acidic to less acidic. Concurrently, available P and total P were found to be higher for the irrigated samples than for the non irrigated samples. Organic matter and total N content were lower in the irrigated samples. This can be attributed to the higher mineralisation (OM decomposition) rate of irrigated soils. Cation Exchange Capacity (CEC) was found to be slightly lower for the irrigated soils than the non irrigated ones which possibly occurred due to the relatively lower OM content. Individual basic cations (Ca, Mg, K and Na) as well as base saturation percentages were higher for the irrigated soils than for the non irrigated soils. Exchangeable acidity and exchangeable Al have shown a similar pattern to each other. Their concentrations were, in most cases, lower for the irrigated samples as compared to the non irrigated ones. Generally, irrigation has improved most of the soil quality parameters. However, appropriate management options geared at organic matter build up need still to be sought.

Keywords: Irrigation, soil quality

Hydrological and Hydro-Chemical Investigation for Sustainable Agricultural Management in Bangladesh

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The study area is in the Northwestern part of Bangladesh, which is one of the driest parts of Bangladesh. The Bangladesh government has decided to increase the crop coverage in this part and thus is looking for sustainable agricultural practices and appropriate management approaches for this area. In this study, hydrological and hydro-chemical investigations have been carried out to determine the basic parameters required for the development of a groundwater model.

About 1233 bore-hole logs have been collected for hydrological analysis and model preparation. On the basis of subsurface lithological information, a regional (Manda, Raninagar, Naogaon, Bagmara and Mohanpur ‘Upazila’) and two local scale hydrostratigraphic models, fence diagrams and cross-sections have been prepared using rockworks software 2004. The Hydrostratigraphic model and the fence diagram show the presence of two major aquifer systems in the study area, which is separated by a thin aquitard layer. Model cross sections show that in some places the upper aquifer merges with the lower aquifer. The model cross sections also show that the thickness of the upper aquitard is not uniform in the study area. It shows that in the southwestern part the thickness of the upper clay is about 30 m higher than in the northeastern part. On the other hand, the thickness of the main aquifer (lower aquifer) is higher in the northeastern part of this area than in the southwestern part.

A thickness map of the aquifer was constructed using the sounding interpretation results for the ‘Manda Upazila’ block. This map shows the maximum thickness of 125 m for Chak Siddeshwari and Talpatila areas and this gradually decreases towards the surrounding areas. Comparing the sounding results with the available water quality data, reveals that the aquifer in the lower part bears saline water. Depth contours along the upper surface of the saline zone show that the maximum depth to the saline zone occurs at Talpatila and Chok Siddeshawari areas reaching 114 m.

Hydro-chemical investigations show no remarkable aquifer contamination with arsenic. For better management of crop production in this area, the information of the study will assist to prepare an interactive information system and a decision support system for the government.

Keywords: Aquifer system, Bangladesh, hydrostratigraphic model, irrigation, rockware 2004

Effects of Irrigation Interval, Sowing Method and Nitrogen Application on Forage and Grain Yield of Barley in the Gezira Scheme, Sudan

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The Gezira scheme is the largest gravity irrigated scheme in Sudan with a total area of about 1 million hectares. During the winter season the only crop grown is winter wheat, hence there is plenty of water during this season. The farmers rely entirely on dry sorghum hay during winter. Wheat area covers only one fifth of the whole scheme, the rest of the land stays fallow. Therefore we think of providing a fresh source for green fodder during this season.

This study was carried out in the Gezira Research Farm at Wad Medani during the 2005/2006 season. Barley seems to be a promising winter forage crop. A programme was established to furnish the farmer with a full technical package on how to grow the crop as a forage or for seed production. The study comprised two irrigation intervals (every 10 days and every 15 days); three sowing methods (on flat, 60 cm wide ridges and 80 cm wide ridges), sown on lines at 20 cm spacing). Nitrogen at 86 kg N ha⁻¹ was applied either as one dose at sowing or in a split dose of 43 kg N ha⁻¹ at sowing and at 30 days after sowing.

The study revealed that:

- Irrigation every 10 days gave the highest plant height, dry weight and grain yield.
- Sowing on 80 cm ridges gave the highest grain yield when nitrogen was added in a split dose.

Keywords: Barley, irrigation, nitrogen, sowing method

Socio-Economic Assessment of Treated Wastewater Irrigation in Northern Gaza

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The use of treated wastewater in irrigated agriculture has the potential to cover at least a part of the increasing water demand in Gaza Strip. The evaluation of the potentials of this alternative water resource requires a multi-stakeholder analysis, i.e. analyses on different social and managerial levels. The treatment process as a first level includes financial and ecological analyses of different treatment methods. The management as a second level focuses on decisions in water pricing and legislation. The third level is the farming population, where analyses include the current state of resource endowment, with special emphasis on water resources, and the contribution of the resources to the living standard. Another element on this level for investigations are perceptions towards the use of treated wastewater for irrigation and the factors affecting the related decisions. The fourth level comprises the consumers of agricultural products and requires analyses of their level of acceptance of and willingness to pay for products irrigated with treated wastewater. The results of these analyses in Northern Gaza allowed for the set-up of linear programming models for different farming systems classes and the formulation of four scenarios with regard to the probable future use of treated wastewater. These scenarios reflect different levels of treatment quality, capacity, costs, and consumers' reactions. The impact assessment indicated the relevance and importance of including the four levels when designing a regional plan to use treated wastewater in irrigation. Decisions on water prices have to consider the socioeconomic situation of the farming population in the setting of water prices, which includes distinctions in pricing according to the specific purpose of treated wastewater use. High prices are economically reasonable and enforceable for irrigation water on hitherto rain fed land, while only lower prices will serve the objective of replacing fresh water. Farmers, who have no own water resources, would accept to use and pay higher prices for treated wastewater compared to farmers who possess wells. The application of this differentiated concept has the potential to facilitate higher adoption rates of using treated wastewater and to generate higher cost-coverage of the water treatment plant.

Keywords: Linear programming models, recycled water, regional model

Assessment of On-Farm Water Use Efficiency in the Public Irrigated Schemes in the River Nile State of Sudan

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The problem of water scarcity worldwide is becoming severe. Water resources are also experiencing an adverse trend viz rainfall rates are decreasing due to the determinant of the vegetation cover, the ground water is dropping.

River Nile State (RNS) is the most important agricultural district in the northern region of Sudan, with its resources endowments; the option of irrigation is mandatory in RNS from the River Nile (RN) by pumps. The scarcity of irrigation water rose due to population pressure. The water diverted for irrigation are not effectively used. It is estimated that on average only 45 % is effectively used by the crop, with an estimated loss of 15 % in the irrigation conveyance system, 15 % in the field channels and 25 % in inefficient field application. This coupled with low crop productivity, lack of cheap source of power, more than 60 % of the RN water flow only during a limited period annually from August to September and lack of tenants' awareness about the recommended amount of crop water requirements. The paper aims to assess the on-farm water efficiency under irrigated sector, the role of State, water users and market allocation manner in structuring the productivity per unit of water used equity and saving water resource of the RNS. Integrated techniques involving economic and hydrologic components are used to assess water use efficiency in RNS. GAMS, Crop Wat4 and Cobb-Douglas function have been employed to evaluate the on-farm water efficiency. The results suggest that vast irrigation water devoted for agricultural production in the State coupled with low production will need attention on water management, allocation, quantities and introduction of water saving technologies. Water management institutions are not well qualified to handle irrigation water. Lack of tenants' awareness led to inefficient water use. These are the major challenges that might save irrigation water in the future.

Keywords: Sudan, water quantities, yield per unit water

Cropping techniques in dry and humid areas

Oral Presentations	481
SITHIDECH ROYGRONG, WOLFRAM SPREER, WINAI WIRIYA-ALONGKORN, PITTAYA SRUAMSIRI, TORSTEN MÜLLER, VOLKER RÖMHELD: Partial Canopy Shading as a Remedy of Leaf Chlorosis and its Influence on Flowering of Lychee Trees	481
WINAI WIRIYA-ALONGKORN, SITHIDECH ROYGRONG, WOLFRAM SPREER, SOMCHAI ONGPRASERT, VOLKER RÖMHELD, TORSTEN MÜLLER: Effectiveness of Micro-Nutrient Fertilisation in Off-Season Longan Production in Northern Thailand	482
AMINA SAIED, JENS GEBAUER, MUHAMMAD SOHAIL, ANDREAS BUERKERT: <i>Z. spina-christi</i> and <i>G. tenax</i> as Promising Fruit Trees for Afforestation in Northern Sudan	483
CHRISTINE KREYE, GEORGES REVERSAT, LUZVIMINDA FERNANDEZ, CASIANA VERA CRUZ, FRANCISCO ELAZEGUI, LIZZIDA LLORCA, JAMIE FARONILO, BAS BOUMAN: Aerobic Rice, a Water-Saving Rice Production System, and the Risk of Yield Failure - A Case Study from the Philippines	484
Posters	485
MAJA HERTEL, PETRA SCHMITTER, TRAN DUC VIEN, GERD DERCON, THOMAS HILGER, GEORG CADISCH: Spatial Variability in Yield and Growth Performance along Rice Paddies in the Mountainous Regions of North-West Viet Nam	485
PAO SREAN, SOPHAL CHUONG, VISALSOK TOUCH, VATHANA SANN: The Effect of Using Organic Fertiliser on Yield of Rice Produced in System of Rice Intensification	486
TOLERA ABERA GOSHU, DABA FEYISA ARAREMME, MOHAMMED HASAN YUSUF, NEGASSA CHEWAKA WAKENE: Effects of Tillage System, Previous Crops and N-P Rate on Agronomic Parameters of Wheat at Shambo in Horro Highlands, Ethiopia	487

HAIDER SHAPO, ADAM ADAM: Effects of Alley Cropping on Microclimate and Some Winter Crop Productivity in Northern Sudan	488
MORITZ RECKLING, JENS GEBAUER, ANDREAS BUERKERT: Effects of Temperature and Water Availability on Plant Growth and Artemisinin Concentration of <i>Artemisia annua</i> L.	489
AZADEH SALEHI, MASOUD TABARI, JAHANGARAD MOHAM- MADI, ALIREZA ALIARAB: Growth and Nutrient Elements Accumulation in Leaf of <i>Pi- nus eldarica</i> Medw. Trees Irrigated with Municipal Effluents	490
SOMCHAI ONGPRASERT, WINAI WIRIYA-ALONGKORN: The Factors Affecting Longan Flower Induction by Chlorate	491

Partial Canopy Shading as a Remedy of Leaf Chlorosis and its Influence on Flowering of Lychee Trees

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Lychee (*Litchi chinensis* Sonn.) is one of the most important cash crops of northern Thailand. As the trees require low temperatures to induce flowering, lychee production is restricted to upland areas with shallow top soils that lack many nutrients, especially micro-nutrients, such as B and Zn. It has been observed that many trees are affected by leaf chlorosis with negative impact on plant performance. The hypothesis was that these chlorosis are a result of micro-nutrient deficiency in combination with high light intensity, as they occur during the winter months of November and December, where light intensity is highest due to cloudless sky.

To overcome the leaf chlorosis and to analyse their impact on flower induction, ten 15-year-old 'Hong Huay' lychee trees were partially shaded with black polyvinyl screens (light transmittance: 50%). The shading took place in October 2006 (two months before flowering) and was applied to single branches of southwest exposition whose leaves are especially susceptible to chlorosis. Between October 2006 and April 2007, the chlorophyll concentration in lychee leaves with and without shading was determined by use of a SPAD metre (Minolta 501) as an indicator for occurrence and intensity of chlorosis. Flowering was evaluated in February 2007. The photosynthetic rate was determined by use of gas exchange measurements (CIRAS 1, PP systems) for shaded and non-shaded and chlorotic and non-chlorotic leaves, respectively. Shading had a significant effect on leaf chlorophyll concentration after one month. SPAD reading of shaded leaves - without typical Zn deficiency symptoms - was higher (SPAD value 40–60) as compared to non-shaded leaves (SPAD value 20–30). In contrast to expectations, the percentage of flowering was negatively affected by shading. The photosynthetic rate was significantly higher in leaves without chlorosis as compared to chlorotic leaves and shaded leaves.

These results show that high light intensity was mainly responsible for chlorosis. By shading, the occurrence and intensity of chlorosis could be decreased. However, shaded leaves had a lower photosynthetic rate, so that the plant performance and particularly flower induction were adversely affected. Other measures to prevent chlorosis, e.g. improvement of the nutritional status are required.

Keywords: Chlorophyll, *Litchi chinensis*, micro-nutrients, photosynthesis

Effectiveness of Micro-Nutrient Fertilisation in Off-Season Longan Production in Northern Thailand

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Longan (*Dimocarpus longan*, L.) is one of the most important fruit trees of northern Thailand. Most of the fruits are produced during the main season (January until July) and marketed fresh, while only a minor part is conserved. An increased production area has led to a massive decay of in-season longan prices. Therefore, more and more farmers shift to off-season production by chemically induced flowering during June or August, so that they can harvest in December or March, respectively, when longan prices are higher.

Most of the longan plantations are in the low lands of the Ping River Basin or the lower foothills along the valley on soils with a poor nutritional status. This is especially true with regard to the supply with micro nutrients, which for a long time have not been considered essential by local farmers. Nowadays, foliar application of micro-nutrient cocktails is practised by many farmers. However, most of them do not distinguish between on-season and off-season production. Micro nutrient cocktails are expensive and, therefore, need to be scheduled carefully to ensure effective uptake by the trees. The aim of this study was to determine out the differences between different phenological stages with respect to micro-nutrient supply and compare them between on- and off-season production. In cooperation with local farmers, ten longan orchards in the Provinces Chiang Mai and Lamphun, northern Thailand, have been surveyed. The orchards differed in frequency and intensity of micro-nutrient application. Fertiliser treatments of local farmers practice have been recorded. Soil samples were analysed on their nutritional status. Longan leaves have been analysed on B and Zn contents for the time periods of flowering, fruit development and after harvest.

It turned out that Zn deficiencies in the soil can be easily overcome by foliar application. The level of Zn content in the leaves decreases massively after harvest, while B remains on a constant level. B was found to be deficient in many orchards. It could only be overcome by frequent foliar application.

Keywords: Boron, foliar application, nutritional status, zinc

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***Z. spina-christi* and *G. tenax* as Promising Fruit Trees for Afforestation in Northern Sudan**

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The northern two-thirds of Sudan are in the arid, semi-arid and low rainfall savanna with an annual maximum rainfall of 500 mm. The majority of population in this area depends on subsistence-agriculture and pastoralism. Studies showed that due to the ongoing land degradation per capita food production has declined significantly over the last decades and there is on-going debate on how to reverse this trend.

Indigenous plant species can play a vital role in land reclamation and enhanced food production. *Ziziphus spina-christi* and *Grewia tenax* are two multipurpose fruit species which are not only adapted to high temperatures and dry conditions, but also produce edible fruits and have deep roots which stabilize sand dunes. However, little is known about how to increase their propagation and early seedling establishment under the harsh conditions of northern Sudan.

Due to their hard seed coats *Z. spina-christi* seeds have a strong mechanical dormancy. In this study, besides untreated seeds, two mechanical and three acid scarification methods were used namely, scratching with sand paper at the hilum, cracking of the seedcoat and immersion in sulphuric acid for 30, 60 and 120 min to enhance germination. Final emergence was highest after immersing seeds in acid for 120 minutes. Mechanical and acid scarification, with the exception of the 30 min acid treatment, improved germination of *Z. spina-christi* by decreasing days to first emergence (E_{1st}) by 4 to 2 days, days to 50% emergence (E_{50}) by 12 to 10 days, and mean days to germination (MDG) by 4 to 2 days. Cracking of the seedcoat resulted in lowest E_{1st} , E_{50} and MDG .

To study the salt tolerance of *G. tenax*, seedlings (6 weeks old) were grown in a sand culture and supplied with nutrient solution to which 0, 20, 40 and 80 mM NaCl was added. As after 4 weeks of salt stress treatment no visible symptoms were observed, salt levels were doubled to 0, 40, 80 and 160 mM NaCl. Weekly measurements of leaf number showed significant reductions for the 80 and 160 mM NaCl treatments as compared to the salt-free control, however the reduction of plant height was only significant for the 160 mM salt level. The highest salt treatment reduced leaf chlorophyll content by 21%. Measurements of leaf gas exchange showed that stomatal conductance was most sensitive to salt stress. After 3 weeks of salt application, this parameter was reduced by 29% for the 80 mM salt treatment. Net photosynthesis was reduced by 29% and 42% at the 80 and 160 mM NaCl, respectively, while leaf internal CO₂ was increased by 72% at the 160 mM salt level.

Keywords: Afforestation, *Grewia tenax*, indigenous fruit trees, salinity, seed germination, *Ziziphus spina-christi*

Aerobic Rice, a Water-Saving Rice Production System, and the Risk of Yield Failure - A Case Study from the Philippines

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Aerobic rice is a water-saving rice production system for water-short environments with favourable soils where adapted, potentially high yielding varieties are dry seeded into fields that are maintained at aerobic non-submerged conditions. Supplementary irrigation is applied as necessary. In the Philippines, wet season yields were 4 to more than 5 t ha⁻¹. In the dry season (DS), however, yields ranged from more than 6 t ha⁻¹ to complete failures of yield. The possible reasons are low soil moisture itself, nutritional problems associated with aerobic soil conditions, and soil health problems such as parasitic nematodes, pathogenic fungi or allelopathy. Dap Dap, a location with sandy loam soil in Luzon, the Philippines, where such a collapse of yield occurred in previous experiments was selected for a case study. As in those earlier trials, root-knot nematodes were observed in high numbers these were suspected to be the main problem. Two treatments were implemented in the DS 2006 and 2007 at four replications in a randomised complete block design using the improved upland variety Apo: a) control of direct dry seeded rice and aerobic soil conditions b) as control but with biocide application (Dazomet at 50 g ai m⁻², incorporated in 15 cm depth) to eliminate biotic stresses. Irrigation was applied regularly to avoid severe water stress; irrigation amounts were recorded as well as soil moisture. Yield, and at crucial crop growth stages biomass development was measured and root-knot nematodes counted. The status of root health was assessed from biweekly root samples, using a grading scale from 1 to 9, and from an examination for root pathogens of these samples. Plant samples from mid-tillering and panicle initiation stages were analysed for nutrient deficiencies and the effect of biocide application on soil nitrate and ammonium was assessed through KCl-extractable N from soil samples collected at different crop growth stages. In this contribution, 2 year's results and their analysis will be presented.

Keywords: Aerobic rice, root knot nematode, soil health, water-saving rice production

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Spatial Variability in Yield and Growth Performance along Rice Paddies in the Mountainous Regions of North-West Viet Nam

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In the mountainous regions of northern Viet Nam, the majority of the rapidly growing population depends on the cultivation of paddy rice in lowlands and crops such as maize and cassava on upland areas with relatively steep slopes which are highly susceptible to degradation by erosion. Both systems, however, are often linked with each other. Runoff water translocates soil particles to lower areas where the deposited sediments may have a significant impact on the nutrient balance, yields and crop performance of paddy rice. This study focus on a better understanding of the influence of land-use intensification and related nutrient flows from uplands on the productivity of paddy rice in the lowlands. The aim was, therefore, to assess the effect of sediment loaded irrigation water on the spatial variability of rice growth and yield along a sequence of paddy rice terraces. The study was conducted in the Yen Chau District, Son La Province, Northwest Viet Nam, i.e. in Ban Me and Ban Put, two villages located in an intensively cultivated sub-catchment within the Chieng Khoi Commune. Data on leaf chlorophyll content, leaf area index (LAI), tillers per hill, plant height, and yield parameters of Nem 87, a short duration hybrid rice variety of 120 days, were collected in four sequences of paddy fields during February and June 2007. All fields were subdivided into fertilised and non-fertilised parts to identify the effect of incoming sediments on the soil fertility of the paddy fields. Data were collected at five growth stages, following a grid to assess spatial variability within a field. Chlorophyll content and LAI were assessed by using a SPAD-502 and a LAI-2000 metre respectively. Two months after transplanting, plots showed clear trends of spatial variability in crop response wich was related to flow directions of irrigation water and distance to the irrigation channel. Data collection is in progress and will allow a critical assessment of trade-offs and interactions between upland and lowland systems and provides information for improving agricultural production in these fragile ecosystems.

Keywords: Chlorophyll, crop response, LAI, paddy rice, spatial variability

The Effect of Using Organic Fertiliser on Yield of Rice Produced in System of Rice Intensification

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The average rice yield of 1.75 t ha⁻¹ in Cambodia is relatively low compared to the other nearby countries. Profoundly the level of applied fertilisers is the major factor involved in this low productivity. The aim of this experiment, therefore, was to evaluate the effects of using different fertilisers on the yield of Phkar Romdoul rice variety.

This experiment was conducted in the rainy season of 2005 (Jul - Nov). The procedure of System of Rice Intensification was applied. The experiment with randomised-completed block design was conducted with 3 different fertilisers and 4 replications. In Treatment 1, 5 t ha⁻¹ of compost (1 % N, 1.72 % P, 2.22 % K) and was used solely as basal fertiliser. Rice in Treatment 2 was supplemented with 50 kg ha⁻¹ of DAP as basal fertiliser, and 30 kg ha⁻¹ of urea and another 30 kg ha⁻¹ of urea at 25 days after transplanted and at grain-forming period respectively. The fertilising application in Treatment 3 were 5 t ha⁻¹ of compost as basal fertiliser, 15 kg ha⁻¹ of urea after transplanting, and 15 kg ha⁻¹ of urea during panicle initial period. In each plot, 15 days-old rice seedlings were directly transplanted with 30cm*30 cm tiller space on a 4m*6m plot space.

There was no significant difference in plant height among treatments (136.16, 139.46, and 141.15 cm in Treatment 1, 2, and 3 respectively). The productive tiller in treatment 1, 2 and 3 were 16, 17, and 16 respectively ($p > 0.05$). The panicle length and the grain numbers in each panicle were 26.01, 26.48, and 26.41 cm, and 187, 178, and 190 grain respectively. The weight of 1000 grains in Treatment 1, 2, and 3 were 28.26, 29.00, and 29.30 g respectively. No significant difference in yield was observed among treatments (4.84, 5.09, and 5.47 t ha⁻¹ in Treatment 1, 2, and 3).

In the cultural hydromorphic soil condition, using 5 t ha⁻¹ of compost, equivalent to 50, 86, and 111 kg ha⁻¹ of N, P, K respectively) provided growth and yield of Phkar Romdul rice similar to those provided by chemical fertiliser. Organic fertiliser can be an alternative option for rice production.

Keywords: Organic fertilizer, rice production, system of rice intensification

Effects of Tillage System, Previous Crops and N-P Rate on Agronomic Parameters of Wheat at Shambo in Horro Highlands, Ethiopia

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In the Horro highlands, wheat cultivation with conventional tillage and N-P fertiliser application on fields that had previously other crops, is the common system for small-holder farmers. In this area, the effects of conventional and minimum tillage, the previous crops and the rate of N-P fertiliser on wheat yield have not previously been tested. A trial was conducted to compare the effects of tillage system, previous crops and N-P fertiliser rate on wheat yield. Two-tillage systems (minimum and conventional tillage), three-previous crops (Niger seed, faba bean and barley) and two N-P rates (75 % and 100 % of the recommended fertiliser rate) were tested and compared with continuous wheat for both tillage systems in three replications.

Tillage system, previous crop and N-P fertiliser rate significantly influenced wheat grain and straw yield. Minimum tillage gave higher grain and straw yield. Wheat following Niger seed, gave higher grain and straw yield, followed by faba bean and barley as compared to continuous wheat. Highest wheat grain and straw yield were obtained from with minimum tillage, following Niger seed and faba bean with the recommended N-P fertiliser rate. Niger seed and faba bean were the best precursor crop for wheat production in the region. Application of recommended rate of fertilisers following previous crops was necessary for wheat production. Thus integrated use of these factors have the potential to increase wheat grain yield in Horro highlands.

Keywords: Cropping sequence, fertiliser rate, tillage system

Effects of Alley Cropping on Microclimate and Some Winter Crop Productivity in Northern Sudan

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Field experiments were conducted in the semi-arid regions of northern Sudan during 1999–2000 to examine the influence of micro-environmental elements on the growth and yield of wheat, faba bean and common bean in an alley cropping system. Above-ground interaction was examined by installing a series of weather stations in different zones of the alleys and control plots for monitoring the microclimatic changes. Shade behaviour (direction and length) was monitored in a systematic way and at regular intervals. Results showed that the solar irradiance in alleycropping plots was reduced by 37 %. Average reduction in maximum and minimum temperature was 1.4°C and 0.7°C respectively, while increase in relative humidity was 8 %. The wind speed was 66 % of the control; irrigation water used in the alleycropping plots was 27 % less than that used in control plots.

The monitored climatic factors had substantial effects on crop behaviour and yield. The southern zone of the alley was permanently shaded, throughout the growing season. This zone showed the highest increase in relative humidity and highest reduction in air temperatures; however, it had the lowest value of solar irradiance. The yields were, therefore, reduced in this zone by 7, 7 and 20 % for wheat, common bean and faba bean, respectively. However, a strong increase in yield in the central alley had compensated for the reduction caused by low radiation in the southern alley. Hence, the average yields in the alley plots increased significantly ($p = 0.01$) over the control by 69, 15 and 10 % for wheat; faba bean and common bean respectively. Ultimately, it becomes evident that the solar radiation was the most influential environmental factor responsible for yield reduction or increase in these alley cropping trials

Keywords: Irradiance, microclimate, alley-cropping, agroforestry

Effects of Temperature and Water Availability on Plant Growth and Artemisinin Concentration of *Artemisia annua* L.

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Artemisia annua L. is under debate as a herbal drug against malaria. This effect has been ascribed to the high leaf concentrations of artemisinin, a sesquiterpene lactone that controls even chloroquine-resistant *Plasmodium* species with little side effects. However, little is known about the optimal agronomic conditions for the growth of *A. annua*, in particular the effects of temperature and water availability on dry matter production and artemisinin concentration. Therefore, an experiment was conducted under controlled conditions to investigate the effects of three different average temperature regimes (20°C, 25°C and 30°C) and two different water levels (sufficient and reduced) on shoot growth of *A. annua* thereby increasing our knowledge about environmental factors on the cultivation of this herb as a drug.

The trial with *A. annua* cv. *anamed*, a cultivar with a particularly high artemisinin concentration in its shoot, showed large effects of temperature and water availability on plant growth, whereas treatment effects on the artemisinin concentration were much lower than expected.

Suboptimal water supply reduced dry matter production by 21–70 % whereas temperatures had little effect on shoot growth.

The artemisinin concentration in plants grown at 20°C and sufficient water level was 19 % higher than that of plants grown at 30°C. At the low water level the lower temperature regime resulted in a 10 % higher artemisinin concentration.

The relatively high concentration of artemisinin in the leaves of the clone used (>1 %) confirms that this breed is of interest as a raw material for a possible plant-based anti-malarial drug in Africa.

Keywords: *Artemisia annua*, malaria, water scarcity

Growth and Nutrient Elements Accumulation in Leaf of *Pinus eldarica* Medw. Trees Irrigated with Municipal Effluents

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Increasing industrialisation and urbanisation has not only deprived production of crops through land degradation but also remained mute witness to the continuous loss of our precious water resources. Attempts have been made to reverse the process of this degradation with afforestation with fast growing tree species and disposal of wastewater safely and economically to tree plantations. In this study, the effects of irrigation with municipal effluent on growth and nutrient elements accumulation in leaf of *Pinus eldarica* Medw. trees were investigated in two areas irrigated by municipal effluent and good water in an urban green space of south Tehran of Iran. For this purpose, four sample plots (30 m×30 m) were systematic-randomly chosen in either of both areas. Measurements in chosen sample plots indicated that diameter at breast height (d.b.h.), total height, crown length, average crown diameter, basal area and volume of *Pinus eldarica* Medw. trees were significantly ($p < 0.01$) greater in area irrigated with municipal effluent than with good water. In each plot, four samples of leaf and soil were taken to determinate the concentrations of N, P, K, Mg, Ca, Na, Fe, Mn, Cu and Zn in laboratory. The results revealed that concentrations of N, P, K, Mg, Ca, Na, Fe, Mn, Cu and Zn in leaf of *Pinus eldarica* Medw. trees and soil were significantly greater in area irrigated with municipal effluent than with good water. The results of this study suggest that municipal effluent can be utilised, as an important source providing required water for afforestation.

Keywords: Afforestation, irrigation, nutrient elements, *Pinus eldarica*, wastewater

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The Factors Affecting Longan Flower Induction by Chlorate

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In 1998 it was found that potassium chlorate induced flowering in longan trees (*Dioscarpus longan* L.). Since then potassium chlorate has been used in most longan orchards in Thailand and some neighbouring countries. Recommended application rate in the early years following the discover was 500 g for a medium size tree. However, after repeated application for 4-5 years many farmers experienced unsatisfactory flower induction. Farmers responded to this phenomenon by increasing the application rates, in certain cases up to 2 kg. This practice did not solve the problem, instead created environmental problems and polluted longan orchards. This research aimed at studying the factors affecting longan flower induction by chlorate. The studied factors were concentration of the substance and plant nutrients, season, shade and the number of time the plants were subjected to chlorate. The study was conducted with 2 year-old potted longan trees cultivated in sand in a plastic house at Mae Jo University.

A concentration of 200 ppm potassium chlorate in the standard nutrient solution was appropriate for inducing flower in the rainy and cool seasons and 400 ppm for the hot season. Toxic symptoms of excess chlorate concentration varied with the concentration, i.e., ranged from reduced flowering with extended flowering period without leaf or apex symptoms to no flowering with leaf burn. Excess concentration of nitrate induced leaf flush and inhibited flowering. Shading for 7 days after the application of chlorate, significantly reduced flowering. Increasing the chlorate concentration was not able to compensate the effect of shading. Repeatedly exposing to chlorate diminished the response of the trees. Split application of several low concentrations of chlorate resulted in comparable flowering as with a single application. The obtained result was able to explain existing phenomena on longan flowering after several years of repeatedly application of chlorate in orchards.

Keywords: Chlorate, flower induction, longan

Plant protection

Oral Presentations	497
CHRISTIAN GENOVA, KATINKA WEINBERGER, ANTONIO ACEDO: Understanding Postharvest Losses in Vegetables Using an Upstream Supply Chain Approach in South East Asia	497
HILDEGARD GARMING, HERMANN WAIBEL: Do Farmers Adopt IPM for Health Reasons? — The Case of Nicaraguan Vegetable Growers	498
MELANIE WIESNER, TAYE TESSEMA, ANDREAS HOFFMANN, PESTEMER WILFRIED, CARMEN BUETTNER, INGA MEWIS, CHRISTIAN ULRICHS: Impact of the Pan-Tropical Weed <i>Parthenium hysterophorus</i> L. on Human Health in Ethiopia	499
ANNA JANKOWSKI, DAGMAR MITHÖFER, BERNHARD LÖHR, HERMANN WAIBEL: Economics of Biological Control in Cabbage Production in Two Countries in East Africa	500
Posters	501
SARWSHRI GANGURDE, KONRAD MARTIN, FRIEDHELM GÖLTENBOTH, JOACHIM SAUERBORN, MARIA JULIET C. CENIZA: Abundance Dynamics of Selected Arthropods in Relationship with Rice Plant Growth, Pests and their Natural Enemies	501
ALI ALI, HELGA SERMANN, CARMEN BUETTNER: Pathogenicity of the Entomopathogenic Fungus <i>Lecanicillium muscarium</i> to Adults of the Mediterranean Fruit Fly <i>Ceratitidis capitata</i>	502
CHARLES ADARKWAH, DANIEL OBENG-OFORI, SABINE PROZELL, MATTHIAS SCHÖLLER, CHRISTOPH REICHMUTH, CARMEN BUETTNER: Potential of the Parasitic Wasp, <i>Lariophagus distinguendus</i> (Förster) (Hymenoptera: Pteromalidae) as a Biological Control Agent for <i>Sitophilus zeamais</i> Motschulsky (Coleoptera: Curculionidae) in Stored Maize	503

- MAYMOONA AHMED EISA, MECHTHILD ROTH, A.E. EL HAS-
SAN, ALI ELBADAWI, R.M. KHAFAGI, M.E. ELAMIN:
Ecological Characteristics of the Millet-worm *Heliocheilus ibipunctella*
(Lepidoptera: Noctuidae), a Pest on Millet-Worm in Sudan 504
- KRITCHAYA ISSAKUL, ELKE PAWELZIK, ARAYA JATISATIENR,
CHAIWAT JATISATIENR, SUCHADA VEARASILP:
Screening of Thai Local Plant Extracts for their Insecticidal
Effectiveness and the Effect of its Active Compound on Dia-
mondback Moth Larvae 505
- KHIN THEIN NYUNT, STEFAN VIDAL:
Predation Efficiency of *Eocanthecona furcellata* on *Helicov-*
***erpa armigera* Larvae Reared on Different Host Plants** 506
- EMANA GETU:
Woolly Whitefly: A Guest Invasive Alien Insect Pest of Citrus
Fruits in Ethiopia 507
- THOMAS KUTTER, ALBA STELLA RIVEROS, BARBARA WICK,
LUIS POCASANGRE, FRANKLIN E. ROSALES, HILMAR SCHRÖDER:
Impact of Organic and Mineral Fertilisation on Banana Growth
and Nematode Populations on Different Soils in Costa Rica 508
- THOMAS HENNIGER, MARTINA BANDTE, CHRISTIAN ULRICHS,
TAYE TESSEMA, SUSANNE VON BARGEN, CARMEN BUETTNER:
Studies on Transmission of the Phyllody of *Parthenium* by
***Cuscuta* sp. and Different Insect-Vectors in Regard to Cul-**
tivated Plants 509
- MELANIE WIESNER, IVONNE ROTH, ARMIN BLIEVERNICH,
CARMEN BUETTNER, TAYE TESSEMA, ARUNAVA GOSWAMI,
INGA MEWIS, CHRISTIAN ULRICHS:
Insecticidal Effects of *Parthenium hysterophorus* Extracts Rich
in Terpenoids and Phenolic Acids 510
- JULIA JANKE, MARTINA BANDTE, CHRISTIAN ULRICHS, TAYE
TESSEMA, SUSANNE VON BARGEN, CARMEN BUETTNER:
Studies on Phyllody in *Parthenium hysterophorus* and Host
Range of Phytoplasma within Important Crops Cultivated in
Ethiopia 511
- CHRISTIAN RUPSCHUS, DIETER KIRSCHKE, CARMEN BUET-
TNER, CHRISTIAN ULRICHS, TAYE TESSEMA:
Economic Impacts of Invasive Weed Species in Developing
Countries: The Case of *Parthenium* in Ethiopia 512
- VISALSOK TOUCH, EDWIN DE KORTE:
The Current Situation of Chemical Pesticide Use on Crops in
Cambodia: Is there Any Driving Force to Halt this Application? 513

YUSRAN YUSRAN, SAFRIZAL SAFRIZAL, MARKUS WEINMANN, GÜNTER NEUMANN, TORSTEN MÜLLER, VOLKER RÖMHELD: Improved Mycorrhisation in Tomato by Soil Inoculation with <i>Pseudomonas</i> sp. Proradix®	514
KALPANA SHARMA, MARIA RENATE FINCKH: Inducibility of Resistance in Tomatoes against <i>Phytophthora infestans</i> by Plant Strengtheners	515
MOJEED LIASU: The Effects of Mycorrhizal Inoculation and Composted Brewery Waste on Growth of Potted Tomato (<i>Lycopersicon esculentum</i> Mill) Plant	516
AUNTIKA SAWATWANICH, PITIPONG THOBUNLUEPOP, CHAIWAT JATISATIENR, SUCHADA VEARASILP, ELKE PAWELZIK, SRISULAK DHEERANUPATTANA, ARAYA JATISATIENR: Using Eugenol for Seed Coating Technology as Storage Fungi Controller in Soybean Seeds	517
PITIPONG THOBUNLUEPOP, CHAIWAT JATISATIENR, ARAYA JATISATIENR, ELKE PAWELZIK, SUCHADA VEARASILP: Comparison of the Inhibitory Effect of Captan, Chitosan-Lignosulphonate Polymer and Eugenol Coated Seeds Against Rice Seed Borne Fungi	518
ANDREA B. LUETTGER, RISHI KUMAR BEHL, GÜNTHER MANSKE, PAUL L. G. VLEK: Arbuscular Mycorrhizal Fungi Infection in Wheat Roots - Effect of Genotypes, Location and Management	519
PRATCHAYA VASSANACHAROEN, WANWARANG PATTANAPO, WOLFGANG LÜCKE, SUCHADA VEARASILP: Radio Frequency Heat Treatment: An Alternative Phytosanitary Processing Method for the Control of <i>Sitophilus oryzae</i> in Milled Rice	520
PIYACHAT AKARANUCHAT, PICHET NOIMANEE, NATTASAK KRITTIGAMAS, DIETER VON HÖRSTEN, SUCHADA VEARASILP: Radio Frequency Heat Treatment: An Alternative Seed Treatment for Seed-Borne Fungi in Barley (<i>Hordeum vulgare</i>)	521
JAMES W. MUTHOMI, GINSON M RIUNGU, JOHN M WAGACHA: Management of Fusarium Head Blight of Wheat Using Antagonistic Microorganisms	522
MAINA MWANGI, CAROLINE NANKINGA, ELDAK KARAMURA: Challenges to Training Stakeholders for Management of Banana <i>Xanthomonas</i> Wilt	523

- ELDUR ZAHKAN, JOACHIM SAUERBORN, ABBASHER AWAD
ABBASHER, ELAMIN ALI AHMED, DORETTE MÜLLER-STÖVER:
**“Pesta” and Alginate Delivery Systems of *Fusarium* spp. for
Biological Control of *Striga hermonthica* (Del.) Benth. under
Sudanese Field Conditions** 524
- ABULEGASIM ELZEIN, BEEDEN FEN, ADOLPHE AVOCANH,
JÜRGEN KROSCHER, PAUL MARLEY, GEORG CADISCH:
**Compatibility of *Striga*-Mycoherbicides with Fungicides De-
livered Using Seed Treatment Technology and its Implication
for *Striga* and Cereal Fungal Diseases Control** 525
- AHMAD FAKHRO, DIETMAR SCHWARZ, PHILIPP FRANKEN,
SUSANNE VON BARGEN, MARTINA BANDTE, CARMEN BUETTNER:
**Application of the Endophyte *Piriformospora indica* in Hydro-
ponic Cultures** 526
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Understanding Postharvest Losses in Vegetables Using an Upstream Supply Chain Approach in South East Asia

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Vegetable produce and processed products from the developing world are gaining greater importance both in domestic and international markets. However, due to the perishable nature of many vegetables, production is severely constrained by high postharvest losses, thereby making production and marketing of vegetables a relatively risky business. Yet, research in this area remains underfunded as evidenced by the scarcity of scientific papers, reliable data sources, and research initiatives examining the magnitude and reasons of postharvest losses in developing countries. Still, there is a growing concern for food quality and safety aspects, since vegetables (together with fruit) belong to the class of food items traded that are most frequently affected by sanitary and phytosanitary measures. This paper provides an overview of the postharvest loss situation of several priority vegetables along the entire supply chain in three Southeast Asian countries, namely Cambodia, Lao PDR and Viet Nam. Looking at the whole supply chain infrastructure and using an analysis of marketing margins, it quantifies the volume and value of vegetable losses from farmers to retailers, and identifies the key reasons and measures being implemented at each stage to reduce postharvest losses. The paper then offers a brief review of the preventive measures in conjunction with the main reasons enumerated per supply chain agent. Analysis of the data indicates that vegetable loss is common to most agents, and on average totals around 17 percent of the total harvest, with a value of approximately US\$ 60 per metric ton produced. Physical loss is highest for farmers, i.e. roughly twice that for middlemen and about 30 percent higher than retailers, while monetary loss is highest for retailers. Results further show that postharvest loss is highest in Cambodia, whose supply chains are more complex than Lao PDR and whose technical expertise is inferior to Viet Nam considering postharvest handling and processing of vegetables. The paper suggests putting emphasis on the development of disease control measures for farmers, and improving marketing efficiency for middlemen and retailers through product quality standards and strengthened rural-urban linkages, e.g. transport conditions, packaging and handling techniques, and market assurance.

Keywords: Developing countries, postharvest loss, Southeast Asia, supply chain, upstream, vegetables

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Do Farmers Adopt IPM for Health Reasons? — The Case of Nicaraguan Vegetable Growers

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Integrated Pest Management (IPM) has been promoted in developing countries because it is considered to increase productivity in a sustainable and environmentally friendly way. Ideally, the use of non-chemical methods of pest control allows farmers to reduce pesticide use, leading to a reduction in health risks from pesticides. This health benefit could provide a major incentive for farmers to adopt IPM, given that they are aware of pesticide health effects and that the substitution of pesticides can be achieved.

This paper investigates the role of farmers' perceptions of health risks of pesticides in the adoption of IPM practices among small-scale vegetable farmers in Nicaragua. Recognizing that health effects depend on changes in pesticide use, we account for two phases of the adoption process. During the experimentation phase, farmers observe the effectiveness of the IPM practices and whether pesticide use can be reduced. Then, based on these experiences, they decide to adopt or not.

For the experimentation phase, a Poisson regression model is used, modelling the number of practices tested by the farmer as a function of perceptions of health risks of pesticides and socio-economic farmer characteristics. The substitution effect of different IPM practices on pesticide use is then analysed in a log-linear regression model.

The results show that perceptions about pesticide health risks like e.g. prior experience of pesticide poisoning are determinants in the farmers' decision to test IPM practices. Also, training and knowledge in IPM and school education increase the number of practices tested. However, it is shown that the use of IPM practices does not substitute for pesticide use, nor do farmers shift towards less toxic products.

It is concluded, that farmers' perceptions of pesticide health risks are a motivation to experiment with IPM practices. However, the options currently available to small-scale vegetable farmers in Nicaragua are still insufficient and not effective in substituting for pesticides, or farmers are lacking information about how to use these methods effectively. Two strategies to reduce pesticide poisoning are proposed: further research on non-chemical pest control in vegetables and continued farmer training in the effective application of existing non-chemical pest control practices.

Keywords: Adoption of IPM, count model, pesticide health effects

Impact of the Pan-Tropical Weed *Parthenium hysterophorus* L. on Human Health in Ethiopia

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Parthenium is an aggressive colonizer of wasteland, roadsides, railsides, watercourses, cultivated fields and overgrazed pastures. The impact on animal and human as well as the economic loss due to spreading of *Parthenium* in Ethiopia is severe.

Parthenium (*Parthenium hysterophorus*) is one of the worst weeds for agriculture, the environment and human health in Ethiopia. *Parthenium* is a genus in the family *Asteraceae*. It is native to Mexico and South America and has spread after its introduction prolifically in Ethiopia and its neighbour countries. Studies in other parts of the world have shown that *Parthenium* inhibits the growth and seed germination of other plants through allelopathy, and can also cause asthma and serious dermatitis in humans. Here most symptoms are contributed to the sesquiterpene lactone parthenin. However, detailed information on dose effects, the impact of other secondary plant compounds on human health, and the economic impact in Ethiopia are still missing. In interviews we asked a total of 64 farmers (19–44 years old) in different infested territories in Ethiopia about their health problems when handling *Parthenium*. The following symptoms could be associated towards *Parthenium*: general illness (80 %, tired, flappy), allergic reactions (90 %, hay fever), asthmatic problems (62 %, contraction of breath muscles, coughing fit), irritations of skin and pustules on hand balls (30 %), stretching and cracking of skin (21 %), stomach pains (22 %, caused by the inhalation of pollen). The irritations of skin continue for one to two weeks. Apart from farmer interviews we have started to identify major secondary plant components in *Parthenium* at different developmental stages. For some of the identified substances we have looked in mouse experiments into the allergic potential. The statistical evaluation of the results is still ongoing.

Keywords: Ethiopia, human health, parthenin, *Parthenium hysterophorus*

Economics of Biological Control in Cabbage Production in Two Countries in East Africa

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A major constraint of cabbage production in Kenya and Tanzania are insect pests, especially the Diamondback Moth (DBM), which is resistant to almost all commonly used pesticides. In 2001, the International Centre of Insect Physiology and Ecology released an exotic parasitoid, which had been highly successful in control of the pest in Asia, for classical biological control of the pest in East Africa. This paper supplements existing *ex ante* impact assessments, conducted during the pilot phase of the project, by presenting the results of a medium term *ex post* economic impact assessment. Data were collected in two surveys in 2004/2005 in Central Province, Kenya, and Northern Zone, Tanzania; two major production areas. The two survey waves were conducted in both dry and rainy season to capture the seasonal variation. The analysis is based on a cross section of 1,291 randomly selected households from both countries. The study used a two-stage damage control production function framework, which treats both pesticide and the presence of biological control as damage abatement agents taking into account the endogeneity problem.

Results demonstrate that farmers producing cabbage in areas where biological control is present use significantly less pesticide compared to farmers from areas without biological control. Farmers in Kenya use a higher amount of pesticide than farmers in Tanzania. Pesticide use is negatively correlated with pesticide price, while it is positively correlated with a pest pressure above normal level. Surprisingly, the damage control function shows that farmers from areas with biological control have significantly lower cabbage revenue than farmers from areas without biological control, although a positive impact of biological control on yield was found. However, decreased pesticide use resulted in health benefits for farmers with biological control. Overall, the results support the notion that introduction of classic biological control as a pest control strategy in the two Eastern African countries does not lead to higher net income, but has positive effects on environmental and farmer's health.

Keywords: Biological control, cabbage, horticulture, Kenya, pesticide, Tanzania

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Abundance Dynamics of Selected Arthropods in Relationship with Rice Plant Growth, Pests and their Natural Enemies

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The cultivation of tropical Asian rice, which may have originated 9,000 years ago, represents an agricultural ecosystem of unrivalled ecological complexity. However, this crop is heavily infested with various pests. These pests have been reported to cause > 80 % damage to rice crop. The control strategies of these pests mainly rely on the application of chemical insecticides. However, indiscriminate use of chemical pesticides has led to health as well as environmental hazards and increasing the cost of cultivation. These studies were conducted in the major irrigated tropical rice fields of Leyte, Philippines. We have observed that abundance of various species of arthropod pests including leaf hoppers (Cicadellidae; Nephrotettix species and others), plant hoppers (Delphacidae), bugs (Pentatomidae, Scotinophara coarctata and Coreidae), Coleoptera (mainly Chrysomelidae) and grasshoppers (Acrididae and Tettigoniidae), their natural enemies includes dragonflies (Anisoptera), damselflies (Zygoptera), ladybird beetles (Coccinellidae) and spiders (Araneae) were highly associated with various stages of the crop growth. In chemical treated site, maximum number of pest population was observed during the early tillering stage and remain present during the whole duration of the crop. Coreidae and Alydidae infested rice simultaneously, and remained abundant together, while Delphacids pests were noticed fare abundance in early stage of the crop. Spiders and Coccinellidae found more during tillering stage to milking stage. However in untreated site Cicadellidae pest was found more abundant during the tillering stage, high number of Alydidae, Coreidae were recorded during the milking and maturity stage of the crop. These results also give correlation as when the pest population developed; the predator population soon became abundant. On average pests found with more abundance than the predators.

Keywords: Abundance, pests, Philippines, population dynamics, predators, rice, spiders

Pathogenicity of the Entomopathogenic Fungus *Lecanicillium muscarium* to Adults of the Mediterranean Fruit Fly *Ceratitis capitata*

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As an alternative to chemical control or as part of IPM programs, there is a resurgence of interest in the use of microbial insecticides for biological control of insect pests. Effects of the entomopathogenic fungus *Lecanicillium muscarium* on the adults of the Mediterranean fruit fly, *Ceratitis capitata* (Diptera: Tephritidae), were determined in laboratory tests.

Flies were obtained from infested guava fruit, collected by the seaside in Syria in September 2006. Fruits were placed on tubs of moist soil. Larvae dropped into the soil and pupated. 25 Pupae per replicate were spread uniformly on the bottom of soil in plastic containers and covered with 2–3 cm layer of moist soil. After that, fungal spores (8.84×10^6 , 8.84×10^5 and 8.84×10^4 spores cm^{-2}) were applied to soil surface using a dash bottle. The emerging adults were exposed to fungal spores on the surface of the soil. Adults were collected every 24 h until the end of emergence than transferred to cages with water and food and incubated at 20°C. There were four replicates for each variants and the untreated control.

The results were:

1. Dead pupae were not infected by *L. muscarium*.
2. There was no effect of *L. muscarium* on adult emergence.
3. But 64.7 % to 78.1 % of emerging adults were infected.
4. Most infected flies died 2 to 6 days after emergence.
5. The dead adults were mouldy with typical white mycelium of *L. muscarium*.

This study indicate that *L. muscarium* can cause mortality of adult stage of *C. capitata* under laboratory conditions.

Keywords: *Ceratitis capitata*, *Lecanicillium muscarium*, mediterranean fruit fly, mortality

Potential of the Parasitic Wasp, *Lariophagus distinguendus* (Förster) (Hymenoptera: Pteromalidae) as a Biological Control Agent for *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae) in Stored Maize

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The parasitic wasp, *Lariophagus distinguendus* is an ectoparasitoid of several beetle species that feed on durable stored products. The potential using *L. distinguendus* for the biological control of *S. zeamais* was assessed in maize stored in storage cylinders. The host finding behaviour of the parasitoid was studied in maize stored in various vertical depths in the cylinders. Holes of 3 mm diameter were drilled through PVC pipes of 20.5 cm length and 20 mm diameter. The pipes were inserted into the holes in the cylinders. An acoustic detector served to identify the maize kernels that contained 3 weeks old larvae of *S. zeamais*. Uninfested maize kernels were filled into the cylinder to depths of 20, 25, 30, 35, 40, 45, 95 and 100 cm, respectively. For depths of 20, 25 and 30 cm, 25 adult *L. distinguendus* aged between 0–14 days were released; for 35, 40 and 45 cm, 30 adult *L. distinguendus* were released while for 95 and 100 cm, 100 adult *L. distinguendus* of the same age were released, each on top of the uninfested maize. Each treatment was repeated three times with control without parasitoids. *L. distinguendus* adults that entered the pipe and the wire mesh cage to parasitise the *S. zeamais* infested maize kernel were collected and placed in a 250 ml glass jars. The emergence of *S. zeamais* was recorded in both *L. distinguendus* treated and untreated maize weekly until the 6th week. *L. distinguendus* penetrated and infested *S. zeamais* stored in the cylinders at the various depths. This showed that *L. distinguendus* was able to find its host in the cylinder with infested maize kernels and produced F1 offspring. *L. distinguendus* also significantly reduced the emergence of *S. zeamais* in stored maize. The significance of these results with respect to the suitability of *L. distinguendus* for the biological control *S. zeamais* is discussed.

Keywords: Maize, parasitic wasp, storage

Ecological Characteristics of the Millet-worm *Heliocheilus albipunctella* (Lepidoptera: Noctuidae), a Pest on Millet-Worm in Sudan

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Sudan is the largest country in Africa with an area of about 2.5 million square kilometers located in northeast and central Africa. Agriculture is the most important sector in the Sudanese economy, in terms of its contribution to GDP (gross domestic product). Millet is grown throughout the country during the rainy season from April to October. Pearl millet (*Pennisetum typhoides* Stapf & Harbbard) is extensively cultivated and used as food in Sahelian countries more than in any other area of Africa. Thus, the major areas of production in Africa are the Sudan and Sahelian zones. It is the staple food for the majority of six million inhabitants of western Sudan, i.e. Kordofan and Darfur states. Among cereals it ranks second to Sorghum both in the area cultivated and also in total production.

The main constraints of the production of millet in west Africa are drought, insect pests, diseases, weeds and birds. After the drought of the sub-saharan belt of west Africa which occurred during the period of 1972–1974 the millet-worm *Heliocheilus albipunctella* became the major pest insect. Yield losses recorded reached more than 85 %.

The presented paper describes the results of field studies carried out in Kordofan State concerning ecological parameters of this millet-worm. The emergence of first instar larvae in the field was recorded in late August /1993. The highest number of larvae were collected from Dembi and Herhri millet genotypes during September. The results documented that the duration of the larval period ranged from 36–43 days. Pupa-tion took place in a soil depth of 5 - 20 cm. In the upper soil layer (0–5 cm) no pupae were found, and in deeper soil layers (> 20 cm) the number of pupae sharply dropped according to the slight increase of soil moisture and the decrease of soil temperature. Adult females deposited their eggs only on the heads of millet, preferring half-emerged and fully-emerged flowering heads. The results showed that the occurrence of millet worm during the rainy season coincided with the heady stage of the millet. The moth disappeared from the field with the maturity of the crop.

Keywords: Millet, drought, *Heliocheilus albipunctella*, insect pest, millet worm, *Pennisetum typhoides*

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Screening of Thai Local Plant Extracts for their Insecticidal Effectiveness and the Effect of its Active Compound on Diamondback Moth Larvae

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The application of botanical insecticides is one of alternative ways to reduce the use of harmful insecticides in agricultural pest management. Nine species of Thai local plant extracts with known insecticidal properties i.e. *Acorus calamus*, *Eugenia caryophyllus*, *Mammea siamensis* and 6 species of *Stemona* (*S. curtisii*, *S. tuberosa*, *S. burkillii*, *S. kerrii*, *Stemona* unknown 1 and *Stemona* unknown 2) were screened for the highest insecticidal activity by the Brine Shrimp Lethality Test (BST). *M. siamensis* expressed a very strong toxic effect on brine shrimp with the lowest 24 hour LC₅₀ value of 0.072 mg L⁻¹. The purification of its active compound was conducted using chromatographic methods and the BST to select the most effective fraction. The spectroscopic method i.e. MS, IR and NMR were used for the identification of the active compound. Surangin B was finally identified as the active compound. Its insecticidal effectiveness on the 3rd instar larvae of diamondback moth was investigated by topical application and leaf dipping methods in comparison with methomyl. The results indicated that surangin B demonstrated a higher contact activity than methomyl with 24 hour LC₅₀ values of 0.07 and 0.51 g L⁻¹, respectively. Moreover, surangin B also had a stronger antifeedant activity than methomyl with the percent of leaf area damaged of 0.83 and 0.14 % for the surangin B concentration of 0.5 and 1.0 g L⁻¹, respectively. However, methomyl exhibited a lower toxicity with 3.19 and 1.65 % leaf area damaged for the methomyl concentration of 0.5 and 1.0 g L⁻¹, respectively. From the results it can be concluded, that mammea extract might be one of the natural insecticides for the diamondback moth management. However, before the future promotion, its efficiency under field conditions, effects on agricultural products and the ecosystem should be tested for confirmation of its insecticidal effectiveness and safety.

Keywords: Botanical insecticide, diamondback moth, plant extract, surangin B

Predation Efficiency of *Eocanthecona furcellata* on *Helicoverpa armigera* Larvae Reared on Different Host Plants

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The predatory pentatomid bug *Eocanthecona furcellata* (Wolff) (EO) is regarded a potential biological control agent against lepidopteran pests in Southeast Asia. We investigated the predation efficiency of EO with regard to the noctuid *Helicoverpa armigera* (Hübner) (ABW), which is a highly polyphagous agricultural pest, especially in cotton, chickpea and tomato in Myanmar. Specifically, we tested the influence of larval feeding reared on different host plants (cotton, cabbage, chickpea and tomato plants) or artificial diet on bug predation.

In each experiment ten males and females EO adults were used, which were starved for 24 hours before the experiment. ABW larvae were fixed with tape and placed randomly in small plastic boxes before transferring ten EO adults to the centre of the arena. In a second series ABW larvae and their faeces were wrapped with Para film and also tested the same way. Movement of EO was recorded at room temperature.

EO adults preferred to prey on ABW larvae reared on cotton plants (42 %); ABW larvae from cabbage, chickpea and tomato plants were accepted less as prey. ABW larvae fed on artificial diet were not accepted as prey (1 %). 13 % of EO were not actively searching for hosts; however in the experiment with wrapped ABW larvae 38 % were not active, and predation on ABW larvae from cotton was reduced to 25 %. Adding faeces to the larvae did not result in higher predation rates by EO.

Based on these data we recommend to release the predatory bug *Eocanthecona furcellata* in cotton fields as a biocontrol agent for controlling *Helicoverpa armigera* in Myanmar.

Keywords: Cabbage, chickpea, cotton, *Eocanthecona furcellata*, *Helicoverpa armigera*, biological control agent, Myanmar, predatory bug

Woolly Whitefly: A Guest Invasive Alien Insect Pest of Citrus Fruits in Ethiopia

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Citrus fruits are among the most important horticultural crops grown in Ethiopia both for home consumption and generating cash for the family which can be used for purchasing clothes, paying school fee and medical insurance among other things. Citrus fruit production system in Ethiopia ranges from one tree to thousands which are owned both by private farmers (small and large scale) and government. With the increasing trends of citrus fruits production in Ethiopia a number of limiting factors come on board. These limiting factors include soil fertility, invasive weed, diseases and insect pests. Some of these problems resulted in abandoning of citrus farms. However, as the citrus ecosystem is an stable ecosystem some of the problems like the insect pest problems, are counterbalancing with their natural enemies, so that intolerable losses can not be reached most of the time especially with indigenous pests. This is not true for exotic pests like woolly white fly. The woolly whitefly, *Aleurothrixus floccosus* (Maskell), is a new invasive alien insect pest of citrus fruits recorded in Ethiopia in 2001 around Nazareth. Woolly whitefly was recorded in Ethiopia on all citrus fruits, guava and coffee. The pest sucks phloem sap, causing leaves to wilt and drop when populations are large. Honeydew droplets collect dust and support the growth of sooty mold. Heavy infestations where copious amounts of honey dew are produced can result in the blackening of entire trees. Honeydew and sooty mold can also contaminate the fruit. According to the survey made since the occurrence of the pest, it has invaded Central Rift Valley starting from Dukem down to Shashemene. In western Ethiopia, the pest invaded Ambo and Bako. During the survey a pupal parasitoid, *Cales noacki* Howard was recorded on woolly whitefly. In this paper, description of woolly whitefly aided by pictures, its current status in Ethiopia, GIS map showing its spread, and some experiences in the management of the pest both in Ethiopia and elsewhere will be discussed.

Keywords: Citrus fruits, insect damage, GIS, invasive, natural control, sooty mold, woolly whitefly

Impact of Organic and Mineral Fertilisation on Banana Growth and Nematode Populations on Different Soils in Costa Rica

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The two main phytosanitarian problems of banana production in Latin America and the Caribbean are the fungal pathogen *Mycosphaerella fijiensis* Morelet causing the foliar disease Black Sigatoka and the soil nematode infestation of *Radopholus similis*. Fungicides, nematicides and mineral fertilisers therefore applied at high rates lead to excessive economic and ecologic costs. Small scale producers cannot afford these inputs and are highly dependent on alternative technologies. In prior experiments foliar applications of vermicompost-teas from coffee pulp showed beneficial effects on Black Sigatoka resistance.

The present study aims at studying the impact of organic and mineral fertilisation on banana growth and nematode populations on different soils (Inceptisols and Andic Inceptisols) under greenhouse conditions. Soil applications of vermicompost-tea on nematode infestation and banana seedling growth were compared to a standard mineral fertilisation programme and a control treatment. We used topsoils from 2 high and 2 low banana productivity sites in Costa Rica. Banana seedling growth was monitored over 20 weeks. Growth indicators such as “formation of new leaves”, “diameter of the pseudo- thallus”, “shoot length” and “weight” were measured every two weeks. Infestation by nematodes was determined at the end of the experiment after 20 weeks. Nutrient contents of the organic fertiliser, and soil chemical and biological characteristics of the different soils were evaluated as well.

After 20 weeks nematode populations in soil were higher with mineral fertilisation than with vermicompost-tea treatment and the control. Growth of banana seedlings (shoot length, formation of new leaves, weight) was highest with mineral fertilisation, followed by vermicompost-tea and the control. Mineraally fertilised plants exceeded all other treatments by far. Soil types affected growth of banana seedlings as well.

Soil application of vermicompost- tea is economically not feasible due to its low nutrient content. We speculate the tendencies towards better growth rates utilising the vermicompost- tea compared to the standard to be due to the fertilisers microbial support to soil biology. Further studies are required as regards the application of vermicompost-teas and other bio-products in order to develop ecologically and economically sound alternatives to the highly toxic nematocides.

Keywords: Biocontrol, Black Sigatoka, Musa (AAA), nematode management, organic fertiliser

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Studies on Transmission of the Phyllody of *Parthenium* by *Cuscuta* sp. and Different Insect-Vectors in Regard to Cultivated Plants

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Parthenium hysterophorus L. is an annual herb of the *Asteraceae* family, originating from tropical America. It has become an invasive weed in tropical regions worldwide and is known in Ethiopia since 1980 from the region around Dire Dawa. Since then it has spread to the middle-high regions of the Ethiopian highland. Phyllody is an important disease of *P. hysterophorus*, which induces plant stunting and reduces seed production. Its causal agent is thought to be a phytoplasma and seems to be transferred by insect-vectors like leafhoppers. Aims of the study are to identify natural vectors and to investigate transmissibility and hostrange of this plant pathogen in Ethiopia.

Symptomatic plants of *P. hysterophorus*, collected in Ethiopia along roads in the surroundings from Debre Zeit and Nazreth at an altitude of about 1500 m, were used for transmission studies of the phytoplasmas to cultivated plants. Leafhoppers within the family Cicadellidae of a mass rearing established in Ambo as well as seedlings of *Cuscuta campestris*, which are suitable for the transmission of phytoplasmas, were used as experimental vectors. Furthermore, aphids and leafhoppers within the family Tettigometridae were collected from phyllody-infected *P. hysterophorus* plants around Debre Zeit and Nazreth with an exhaustor and transferred separately in 70 % ethanol.

In opposite to previous studies by *Cuscuta campestris* was successfully established on healthy as well as on diseased plants of *P. hysterophorus*. Haustorias predominantly developed at the leaves and leaf-stalks. Especially young and small plants were particular susceptible. Concluding, a method was established to determine the hostrange of the pathogen of the phyllody-disease. The technical course of the transmission studies with leafhoppers was successful, but no characteristic phyllody symptoms at *P. hysterophorus* were induced after transmission experiments with *Cuscuta campestris* and leafhoppers within the family Cicadellidae until now. Collected insects were tested by a phytoplasma specific polymerase chain reaction (PCR). Therefore the primer-pair P1/P7 was applied to amplify an 1800bp rDNA fragment. Gel electrophoresis of PCR reactions, obtained from isolated DNA from different leafhoppers within the family Tettigometrida, revealed products between 1500bp and 2000bp. These results will be confirmed by RFLP-analysis.

Keywords: *Parthenium hysterophorus*, phytoplasma, transmission

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Insecticidal Effects of *Parthenium hysterophorus* Extracts Rich in Terpenoids and Phenolic Acids

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According to the International *Parthenium* Research Group, the origin of the weed *Parthenium hysterophorus* is considered to be Mexico, America, Trinidad and Argentina. It is a fast-maturing annual weed that may reach a height of 2 m. Its leaves are pale green, branched and covered with soft fine hairs. Although it was first recorded in Natal, South Africa, in 1880, it appears to have become common and troublesome only since the 1980s. It is an aggressive colonizer of wasteland, roadsides, cultivated fields, and overgrazed pastures. *Parthenium* is an extremely prolific weed and causes severe economic loss, health problems and habitat destruction. It is known to release allelochemicals that inhibit the germination and growth of pasture grasses and other plants. We wanted to know if such substances also show insecticidal efficacy against insect pests.

In a field study water extracts from shade dried *Parthenium* leaves have been applied to *Brassica juncea*, for controlling mustard aphid, *Lipaphis erysimi* (Kaltenbach). Population density was noted three days after extract application. The extract of *Parthenium* exhibited a tremendous reduction (down to 29 % of the initial infestation) in the number of *L. erysimi*, one of the most important pests of *B. juncea*, may be due to the effect of phenolic acids.

In contact laboratory experiments with methanolic extract against *Harpalus* sp. (Carabidae) and *Aphis fabae* (Aphidae) we could not find any insecticidal effect. However, in choice experiments where insects could choose between treated and untreated plant material, the extracts revealed a strong repellent effect.

To understand differences in results for different extracts we are going to analyse secondary plant components using acidified methanolic extracts from different aerial parts of *Parthenium*. The terpenoid parthenin and different phenolic acids are redissolved in acetonitrile and in 20 % ethanol for HPLC analysis.

Keywords: Ethiopia, insecticidal effect, parthenin, *Parthenium hysterophorus*, phenolic acid

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Studies on Phyllody in *Parthenium hysterophorus* and Host Range of Phytoplasma within Important Crops Cultivated in Ethiopia

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Parthenium hysterophorus is an annual weed that, due to its competitiveness and adaptability to different climatic and soil conditions, is widely spread in Australia, South Asia and parts of East Africa. It was introduced to Ethiopia in the 1980ies and became the major invasive weed in both arable and grazing lands. In Ethiopia a disease caused by phytoplasmas was commonly observed in *Parthenium* (up to 75% field incidence). Diseased plants are characterized by excessive branching, reduced plant height and leaf size, and modification of floral structures into leaf-like structures that lead to sterility.

More than 700 plant diseases are associated with phytoplasmas. Phyllody symptoms caused by phytoplasmas were already found on different crops, e.g. sunn hemp, lupin, field pie, soybean and cowpea. In order to test whether *Parthenium* plants harbours phytoplasmas, which may also infect important agricultural crops in Ethiopia, weeds and cultivated plants showing phyllody symptoms, such as faba bean, chick pea, lentil and grass pea as well as groundnut and sesame, were collected on different locations. Phytoplasma infection of plants was assessed by polymerase chain reaction (PCR) and further characterisation by Restriction Fragment Length Polymorphism (RFLP) analysis of PCR products. Amplified fragments were sequenced allowing species identification of the pathogens. Sequence comparisons of rDNA sequences revealed that phytoplasmas detected in *Parthenium* plants were also present in sesame, groundnut and faba bean. They all belong to the species “Candidatus Phytoplasma aurantifolia” which suggests that *Parthenium* represents a pathogen reservoir for the phytoplasmas affecting agricultural crops in Ethiopia.

Keywords: Ethiopia, *Parthenium hysterophorus*, phyllody, phytoplasmas

Economic Impacts of Invasive Weed Species in Developing Countries: The Case of *Parthenium* in Ethiopia

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Invasive Weed Species are plants that are non-native (alien) to the ecosystem and whose introduction threatens food security, health or economic development and biodiversity. The highly competitive and allergenic weed *Parthenium hysterophorus* was introduced to Ethiopia in 1970s. The weed has spread to the most parts of the country with high infestation rates in grasslands and even in crop fields. It is growing in different habitats from semi-arid low altitude to high-altitude areas. Interviews with farmers and researchers were conducted in several Ethiopian regions in 2006. Semi-structured question guidelines were used in group interviews among 64 farmers to achieve relevant data. Quantitative and qualitative information was collected about yield decline in fields and grassland, decline in animal production, effects on human and animal health and additional labour input due to *Parthenium*. Results show that the existence of *Parthenium* is a growing danger to small-scale farmers: tef and sorghum grain yields are reduced; milk output from dairy cows is decreasing to one third; the remaining milk is inedible due to its sour taste; animals suffer from skin allergy and reduction in weight; farmers suffer from skin allergy, itching, fever and asthma; intensive labour input has to be made in order to clean the crop fields. Even though exact figures cannot be given at the moment due to ongoing evaluation of the obtained data it can be said that the economic dimension of the problem seems to be tremendous. *Parthenium* is a current threat for further economic development in the rural areas of Ethiopia. Therefore effective methods have to be found in order to combat *Parthenium* and other Invasive Weed Species.

Keywords: Economic impact, Ethiopia, invasive weeds, *Parthenium*

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The Current Situation of Chemical Pesticide Use on Crops in Cambodia: Is there Any Driving Force to Halt this Application?

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Pests and diseases dramatically decrease yields and contribute to post-harvest losses of all crops in Cambodia. Even with limited documentation, the use of chemical pesticides (CP) among farmers has resulted in concerns on human health as well as the accompanying environmental problems. The objective of this research, therefore, was to observe the current situation of using CP in different geographical regions in Cambodia.

The survey was conducted in 3 provinces in Cambodia namely Battambang (Northern), Kampong Thom (Middle), and Takeo (Eastern) province. In these provinces the agricultural technology adaptation among farmers is influenced by Thailand, Cambodia, and Vietnam respectively. 37 Farmers using chemical and home-made plant-based pesticides were interviewed in each province.

It was observed that CP were used predominantly in Takeo (81 %), following by the Battambang (65 %) and the Kampong Thom (59 %) provinces. Limitation of indigenous knowledge in preparing organic pesticide among farmers contributed to 44 % of decision in applying CP, following by the availability of CP on the market (22 %) and its quick reaction (19 %), and other reasons(15 %). While the 3 latter observations were not significantly different among regions, it is pointed out that limitation on indigenous knowledge was very important in Takeo (81 %) and following by Kampong Thom (43 %). Educations and training programs for farmers by various institutions reduced the application of CP among farmers. Overall, on average, 44 % of farmers decided to abandon the use of CP due to health problems, whereas 27 % stopped using CP as they knew alternative methods of pest control. 9 % Stopped due to the high costs of CP and another 20 % for other reasons. The latter case was mainly due to the membership of farmers in ?organic communities? active in some of the surveyed provinces. Health problems as a decision-factor to discontinue the use of CP was profoundly observed in Takeo (57 %) whereas high possibility of finding alternative choice was stated highest in Kampong Thom (32 %).

Remarkably, the majority of farmers are still using CP. According to the survey health problems are the main driving force for farmers to discontinue the use of CP. Because those farmers who decided to stop using CP are already the victim or even becoming disabled, caution and attention on the use of CP must be drawn.

Keywords: Cambodia, chemical pesticide, natural pesticides, health problems

Improved Mycorrhisation in Tomato by Soil Inoculation with *Pseudomonas* sp. Proradix®

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Arbuscular mycorrhizal fungi (AMF) are regarded as an important factor for the uptake of phosphorus (P) and other relatively immobile nutrients particularly in low input systems. Furthermore, AMF support healthy growth of plants being involved in the resistance against toxic elements and suppression of pathogens. In arable land, however, mycorrhisation of plant roots may often be insufficient as a consequence of few AMF propagules, competition with deleterious soil microbes or stunted root growth. Large-scale soil inoculation with appropriate AMF is usually not practicable considering the costs and problems of inoculum production. As an alternative single studies have shown the potential for application of beneficial rhizobacteria to improve root infection with the indigenous, site-specific and adapted AMF flora.

In this study, the effect of a commercial fluorescent *Pseudomonas* ssp. strain *Pseudomonas* sp. proradix® (Proradix®, Sourcon-Padana GmbH & Co. KG, Tübingen, Germany) on mycorrhisation improvement, nutrient acquisition and growth of tomato (*Lycopersicon esculentum* Mill.) plants was tested in a green house experiment. Tomatoes are an important vegetable produced in Indonesia. This investigation is a prerequisite for the ongoing development of bioeffectors useful under humid tropical conditions.

Two tomato seeds were cultivated in pots containing 1.7 kg dry matter of a loess/sand mixture (3:1) with increasing levels (approx.: 0; 800; 4000; 8000 propagules per pot) of AMF-inoculum (*Glomus intraradices* strain 510, Mycotec Biotechnik Gbr, D-30419 Hanover) with and without *Pseudomonas* sp. proradix® (1.5×10^{10} cfu per pot). 100 N, 50 P, 150 K, 50 Mg, 0.06 Fe mg kg⁻¹ loess dry matter were fertilised. Proradix® significantly improved the establishment of AMF in tomato roots. Root and shoot biomass production of tomato was positively affected by Proradix®, which was particularly pronounced in the soil without AM-inoculum. The P-concentration in tomato shoots increased with increasing application rate of the AM-inoculum, whereas the additional effect of Proradix® was small and only observed in the treatments with low rates of AM inoculation. Manganese concentrations in shoot tissue declined with increasing AM application rates and were additionally lowered by Proradix®. The results suggest that *Pseudomonas* sp. proradix® is a mycorrhisation helper bacterium.

Keywords: AMF, pseudomonades, low input systems, mycorrhizal management

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Inducibility of Resistance in Tomatoes against *Phytophthora infestans* by Plant Strengtheners

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Resistance induction is a commonly observed phenomenon in many plants and usually occurs in reaction to exposure to avirulent pathogens or certain chemicals (e.g. BABA). Induction can be achieved via the leaves and there is evidence that some plant strengthening products can induce resistance via the root. Currently we are working on the possibility to use induced resistance in tomato against *Phytophthora infestans*, causal agent of late blight by selecting more inducible varieties and the compounds that can be best used to induce resistance in practice with an emphasis on products that are easy to be applied preferably via the soil.

A total of 32 tomato varieties with various levels of susceptibility to late blight were grown in standard soil with mineral fertilisers. Detached leaves of 1 month old plants were screened for inducibility of resistance using BABA (DL-3-amino butyric acid) seven days before challenge inoculation. Control plants were sprayed with distilled water in a similar way. Leaves directly treated with BABA (old) and newly grown leaves (young) were included in the test. Resistance induction was usually higher on leaves newly grown after treatment than on old leaves that had been directly treated by BABA. The degree of induction varied among varieties based on the absolute (measured in cm² diseased leaf area) and relative disease reduction achieved through the use of BABA with several varieties showing no induction at all and others more than 90% disease reduction.

Based on the initial screening, various varieties were tested for their inducibility under greenhouse conditions using field soil, comparing the effects of different organic fertilisers and plant strengtheners on young and adult plants. Soil application of the plant strengthener Quality (Bio-Feed Product), an aqueous extract of herb reduced plant susceptibility in all combinations with fertilisers, soil and plant age between 20% (adult plants) and 46% (young plants). Other strengtheners such as PEN, alfalfa extract, and meat extract usually also enhanced resistance but not as strongly.

Keywords: BABA, late blight, plant strengtheners, resistance induction

The Effects of Mycorrhizal Inoculation and Composted Brewery Waste on Growth of Potted Tomato (*Lycopersicon esculentum* Mill) Plant

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The effects of mycorrhizal inoculation and composted brewery waste on growth of potted tomato [*Lycopersicon esculentum*] plant were investigated in an experiment in which composted (6, and 12 weeks composting) spent sorghum grains were used to supplement garden soil with the unsupplemented soil as control. Both were used as media for the establishment and growth of transplanted tomato seedlings. They were either inoculated or not inoculated with the arbuscular mycorrhizal fungus *Glomus mosseae*. Tomato stem height and width, and the numbers of nodes and leaves per plant were measured at weekly intervals. Transplanted seedlings did not survive in soils amended with brewery waste that had composted for six weeks and only those that were inoculated with *G. mosseae* showed slight (twenty percent) survival. Tomato seedlings grown in the supplemented soils (both inoculated and uninoculated) showed hundred percent survival like those in unsupplemented soils when the brewery wastes were allowed to compost for twelve weeks. Arbuscular mycorrhizal inoculation similarly promoted weekly increases in stem height and stem width of tomato seedlings particularly in soils supplemented with brewery waste after twelve weeks of composting. Number of leaves per plant was more markedly enhanced by AM inoculation in tomatoes grown on unsupplemented soils. Concentrations of Zn, Fe, Pb and Cd in both soil and brewery waste samples were below the Federal Environmental Protection Agency (FEPA) safe levels. *Micrococcus acidophilus* and *Streptococcus faecium* were bacterial isolates from the brewery waste supplement. Inoculation with *Glomus mosseae* promoted the growth of tomato in soils supplemented with composted spent sorghum grains. Brewery waste i.e. spent sorghum grains can be used as organic soil supplement for cultivating tomato only after an appreciable period of composting, and the negative effect of a shorter period of composting could probably be mitigated by AM inoculation.

Keywords: AM inoculation, composting, *Glomus mosseae*, soil supplementation, tomato

Using Eugenol for Seed Coating Technology as Storage Fungi Controller in Soybean Seeds

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The efficiency of an eugenol treatment of soybean seeds against some fungi during storage was determined in comparison with synthetic chemicals. The seed-coating formulation consisted of 1 % eugenol, 2 % chitosan, 0.01 % lignosulphonic acid, 1 % acetic acid and 95.99 % distilled water. Four treatments i.e seeds coated with chitosan, chitosan plus eugenol, seeds mixed with captan, and untreated seeds, were performed. All seeds were kept at 15°C with 60 % relative humidity for 6 months. Every month, the inhibition percentage of all treatments against fungi and the standard germination test were determined by the blotter method. The results showed that captan had the highest tendency to control all studied fungi.

The captan treated seeds were protected from the infection by *Colletotrichum* sp. for 5 months with an inhibition rate decreasing from 79.0 to 27.3% and from the infection by *Cladosporium* sp. and *Macrophomina* sp. for 4 months, with a decrease from 100.0 to 33.3 and 80.0 to 45.8 inhibition percentages, respectively. Chitosan plus eugenol showed the highest efficiency to control the growth of *Cladosporium* sp. for 4 months (decrease from 100.0 to 33.3 inhibition percentage) and the growth of *Colletotrichum* sp. and *Macrophomina* sp. for 3 months with a decrease from 70.00 to 46.2 and 83.3 to 47.4 inhibition percentages, respectively. Chitosan was effective against the growth of *Cladosporium* sp. for 3 months (decrease from 85.7 to 47.6 inhibition percentage) and controlled the growth of *A. flavus*, *Colletotrichum* sp. and *Macrophomina* sp. for 2 months, with inhibition percentages decreasing from 66.7 to 38.5, 72.0 to 42.3 and 72.2 to 36.8 respectively. Results of standard germination test showed that seed coating with chitosan, and chitosan plus eugenol could prolong the seed viability better than captan treatment. The germination percentage changed from 92 to 74%, 92 to 72% and 90 to 68%, respectively. However, during seed storage, the efficiency against the tested fungi and germination percentage of all treatments gradually decreased.

Keywords: Antifungal activity, essential oil, film-coated polymer, fungicide

Comparison of the Inhibitory Effect of Captan, Chitosan-Lignosulphonate Polymer and Eugenol Coated Seeds Against Rice Seed Borne Fungi

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Presently, chemical seed treatments are in discussion due to their possible directly or indirectly impacts on human health or other living organisms. They may also negatively affect the ecosystem and the food chain. In rice seeds, chemicals may cause phytotoxic effects including grain degradation. Eugenol is the main component of clove (*Eugenia caryophyllis*) oil and it is known as an active agent against many pathogenic seed borne fungi. It acts simultaneously as bactericide, fungicide and viricide. Moreover, it is non-toxic for humans if it is applied in normal doses. The present study compared the inhibitory effect of the following applications for rice seed treatment to protect them against seed borne fungi during 12 months of storage: eugenol incorporated into chitosan-lignosulphonate polymer, only chitosan-lignosulphonate polymer and captan. The Blotter method was used for the determination of seed infection. The obtained results of fungi inhibition showed at first that captan treatment led to a better, i.e. longer, inhibitory effect on *Alternaria padwickii*, *Rhizoctonia solani*, *Curvularia* sp., *Aspergillus flavus*, and *Aspergillus niger* than eugenol incorporated into chitosan-lignosulphonate polymer. Secondly, eugenol incorporated into chitosan-lignosulphonate polymer showed the longest inhibitory effect against *Bipolaris oryzae* and *Nigrospora oryzae* compared to captan and only chitosan-lignosulphonate polymer treatments. Finally, both captan and eugenol incorporated into chitosan-lignosulphonate polymer showed non-significant different inhibitory effect on *Fusarium moniliforme*. The variant of only chitosan-lignosulphonate polymer for seed coating was only during the first 6 months of storage able to inhibit all species of the observed seed borne fungi, whereas captan and eugenol incorporated into chitosan-lignosulphonate polymer were capable to inhibit most of the fungi until 9 months of storage.

Keywords: Antifungal activity, eugenol, rice seed borne fungi, seed coating technology

Arbuscular Mycorrhizal Fungi Infection in Wheat Roots - Effect of Genotypes, Location and Management

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Wheat (*Triticum aestivum* L.) as one of the major food crops is grown under limited water and low nutrient supply conditions in many regions of the world. Therefore, improvement of wheat yields through enhanced nutrient efficiency by using arbuscular mycorrhizal fungi (AMF) as a component of integrated nutrient management strategy is of considerable importance.

A set of field experiments at four locations were conducted on research farm of CCS Haryana Agricultural University, Hisar in north India. The wheat variety WH157 showed highest grain yields at all fertiliser levels whereas 'WL711' only exploited its potential at intensive fertiliser and irrigation level. Under low input conditions (reduced fertiliser, low water level) 'IWP72' showed highest yield. The differences among varieties were more conspicuous at reduced fertiliser level with exception of one location. The root length was significant influenced by location, wheat genotypes and the interaction. Averaged over 3 varieties the root length at anthesis differed about 30 % between locations. 'IWP72' had the lowest root length and 'WH157' reacted most sensitive by changes of the root length of all locations. The wheat root infection rates by the native mycorrhiza of the soil ranged from 0–70 %. The identified mycorrhiza spores belonged to the families Glomaceae, Acaulasporaceae and Gigasporaceae and *Glomus*. Fertiliser levels and location showed apparent influence on the number of mycorrhiza spores and infection intensity. No vesicular-arbuscular mycorrhizae (VAM) infections of the wheat roots were found at the location where waste water instead of canal water was applied. Soil tests revealed almost double content of plant usable Olsen-P, higher C-content and most appropriate C/N ratio compared to the other locations. Certainly this is one reason for high grain and biomass yield. Although the number of VAM spores existing in the soil (170 spores 100g⁻¹ soil) was just as high as the comparable experimental plots the wheat roots were not infected. Sensitivity of AMF spores to heavy metals in waste water or higher soil nutrients and lack of plant signals to VAM may be possible reasons for non infection.

Keywords: VAM, wheat, India, cultivars

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Radio Frequency Heat Treatment: An Alternative Phytosanitary Processing Method for the Control of *Sitophilus oryzae* in Milled Rice

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Sitophilus oryzae (L.) (Rice weevil) infestation of milled rice during storage is one of the biggest problems leading to huge losses of rice worldwide. The weevils destroy the whole kernel. Contaminated rice usually loses flavour and palatability. This study was set up to determine the efficacy of radio frequency (RF) heat treatment as an alternative to conventional chemical fumigation and to establish the lethal doses of RF heat treatment which can be used in controlling *S. oryzae* in milled rice. Milled rice cv. “Khao Dok Mali 105” (KDML105) with 12 % moisture content, infested with *S. oryzae* were heat-treated with RF at 27.12 MHz with a power input of 30 % of the maximal output power of 2800 W. Target temperatures were 45, 47.5, 50, 52.5 and 55°C for 1 minute. A further experiment was carried out using a temperature of 50°C for 0, 1, 3, 5, 10, 15 and 30 minutes. Results showed that using RF at 50°C and higher could effectively be used to control *S. oryzae*.

The Rice weevil was completely eliminated at 50°C using durations of either 15 or 30 minutes. The weevil was also eliminated at 52.5 and 55°C using one minute treatment duration. Therefore, the use of RF heat treatment is effective in controlling *S. oryzae* using a target temperature between 50 and 55°C. Further studies will be carried out to investigate the effect of temperature and duration of treatment on survival of *S. oryzae* eggs, larvae and pupae in milled rice during storage. It will be important as well to establish the effect of RF treatment on rice grain quality.

Keywords: Heat treatment, milled rice, phytosanitary, radio frequency, *Sitophilus oryzae*

Radio Frequency Heat Treatment: An Alternative Seed Treatment for Seed-Borne Fungi in Barley (*Hordeum vulgare*)

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Fungi contamination during the malting process is a major problem in the brewing industry. The conventional seed drying techniques do not eliminate fungi. The aim of this study was to evaluate the efficacy of radio frequency (RF) heat treatment in eliminating seed borne fungi in barley (*Hordeum vulgare*). Barley seed, “Bauding” variety with initial moisture content of 14.5% were treated with RF at 27.12 MHz. The power input was 24% of the maximal output power of 2800 W. Seed health status was determined using the blotter method and standard germination test was carried out using the ISTA rule 2006. The first experiment was set to determine the use of the temperatures: 60, 65, 70, 75 and 80°C over 3 minutes duration. Treating barley seed at 70°C gave the most promising results in controlling seed borne fungi. The infectivity of *Aspergillus flavus*, *Alternaria* sp., *Penicillium* sp. and *Rhizopus* sp. were reduced to 16.67, 11.11, 0 and 0%, respectively at this temperature level. However, at this temperature, seed germination was reduced from 91 to 41%. Therefore while RF heat treatment significantly controlled seed borne fungi in barley seed, it reduced their viability. In the second experiment, barley seed was heated at 65°C RF for 1, 3, 5 and 10 minutes. Heating for 5 and 10 minutes were the most effective. *Aspergillus flavus*, *Alternaria* sp., *Penicillium* sp. and *Rhizopus* sp. infectivity were decreased to 16.67, 0, 0 and 0% at 5 minutes duration while at 10 minutes duration, respective infectivity were reduced to 25, 11.11, 0 and 0%. Germination in this case was decreased from 91 to 78 and 62% on the 5 and 10 minutes duration, respectively. These results show that using 65°C RF heat treatment for 5 minutes is suitable for controlling seed borne fungi in barley seed and leads to reasonable germination percentages. Therefore, RF heat treatment may be used as an alternative method to control seed borne fungi in barley seed.

Keywords: Barley, heat treatment, phytosanitary, radio frequency, seed borne fungi

Management of Fusarium Head Blight of Wheat Using Antagonistic Microorganisms

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Laboratory and green house studies were conducted to evaluate the efficacy of selected antagonists in control of Fusarium head blight. The antagonists tested were *Epicoccum* sp., *Alternaria* sp., *Trichoderma* sp., and *Bacillus* sp. Fungicides folicur® and copper oxychloride were used as standard check. Laboratory assay was carried out by paired cultures where a pathogenic isolate of *Fusarium graminearum* was grown together with an antagonistic isolate. Antagonism was measured as reduction in pathogen colony diameter. Green house experiments involved co-inoculation of pathogen and antagonist onto wheat ears. Head blight severity was assessed as the proportion of spikelets bleached and area under disease progress curve was derived from the severity data. Grain yield was determined after physiological maturity. Mycotoxin deoxynivalenol was determined by ELISA method.

The antagonists and fungicides tested were found to significantly reduce the growth of *Fusarium graminearum* colonies in culture. Fungicides folicur and copper oxychloride reduced pathogen colony growth by 100 % while *Trichoderma* sp. showed 64 % colony growth reduction. The least effective was *Epicoccum* sp.. However, the antagonists showed limited reduction in head blight severity in green house trials. Among the antagonists, *Trichoderma* sp. showed higher disease severity reduction (18 %) while fungicide folicur was most effect with a reduction of 28 %. All the antagonists had little or no significant effect on grain yield. However, co-inoculation of *F. graminearum* with *Alternaria* and *Epicoccum* spp. reduced deoxynivalenol content in the grain but *Trichoderma* and *Bacillus* spp. showed increased levels of the mycotoxin.

The results indicated that some of the antagonist might be useful in the management of Fusarium head blight and the associated deoxynivalenol mycotoxin. However, more studies are required to determine the effectiveness of the antagonists under field conditions and to screen more microorganisms for potential usefulness in management of Fusarium head blight and mycotoxins.

Keywords: Antagonists, deoxynivalenol, fungicides, Fusarium head blight, wheat

Challenges to Training Stakeholders for Management of Banana *Xanthomonas Wilt*

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Xanthomonas wilt of banana (BXW) is having a major adverse effect on banana production in the Great Lakes region of East and Central Africa. Equipping farmers with knowledge to recognise the disease and take appropriate management measures is viewed as the most important component of integrated management of this disease. The Crop Crisis Control Project (C3P) is a regional initiative to address BXW in six affected countries including Burundi, Uganda, Kenya, Rwanda, DR Congo and Tanzania, mainly through education, training and communication programs. Half of the countries are French speaking and the other half are English speaking. The C3P training programme was initiated with two regional training workshops carried out in September/October 2006, each lasting one week long. One workshop was on production of healthy banana planting materials through newly introduced macro-propagation technology while the second workshop was on diagnosis and management of BXW. The participants from each country were selected to represent technical, extension, and policy making institutions and upon return to their countries the participants were expected to organise training for more people to further spread knowledge for BXW management downwards to farmer level. In addition to lectures and field visits, additional course materials were provided to participants as handouts and electronic copies (CD and flash sticks).

The major challenge in executing a regional training programme was in communicating simultaneously to a combined audience of French and English speakers. In one workshop this challenge was addressed by having a bilingual trainer while in the other a simultaneous translation system was used. When a bilingual trainer was used the sessions took twice as long while field sessions faced difficulties since the simultaneous translation system could not be used under field conditions. However, even without efficient translation, there was a significant improvement from ≈ 60 to >85 % in understanding of BXW after field demonstrations. Additional challenges are identified as course notes available only in one language (≈ 70 % of French speakers) and lack of access to computers hence low utilisation of electronic training materials (≈ 60 %). The paper examines challenges and documents various approaches of communicating IPM to multilingual audiences.

Keywords: Banana, C3P, farmer training, *Xanthomonas wilt*

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“Pesta” and Alginate Delivery Systems of *Fusarium* spp. for Biological Control of *Striga hermonthica* (Del.) Benth. under Sudanese Field Conditions

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The parasitic weed *Striga hermonthica* is the main biotic factor affecting sorghum, maize and millet production in the Semi-Arid Tropics. Since there is no simple, fast and inexpensive solution to the *Striga* problem, biological control with phytopathogenic fungi could be a beneficial alternative within an integrated control approach. Field experiments were conducted at Gezira, Sudan in two consecutive seasons (2003/2004), to study the efficacy of two biological agents (*Fusarium nygamai* (FN) and *Fusarium* sp. “Abuharaz” (FA)) formulated in wheat flour-kaolin granules (made by mixing fungal inoculum with wheat flour (semolia), sucrose and kaolin to form granules using a hand-operated “Pesta machine”) on *Striga* infestation and to determine the dose needed for effective weed control. Furthermore, an alginate formulation was tested as alternative delivery system. In the first season the highest control efficacy was achieved by applying FA in “Pesta” granules at 1.5 g planting⁻¹ hole, which reduced the total number of parasite shoots by 82 % and the number of healthy *Striga* shoots by 88 % compared to the untreated control. As a consequence, sorghum biomass and sorghum 100-seed weight were increased by 88 % and 110 %, respectively, compared to the untreated control. FN and the combination of the fungal isolates were slightly less efficient in controlling the parasites. During the second season all preparations applied at 1.5 g planting⁻¹ hole showed a lower efficacy in reducing *Striga* total number compared to the first season. Nevertheless, FA formulated in “Pesta” or alginate pellets caused disease in 74 and 80 % of the *Striga* plants, respectively, and consequently improved sorghum performance. Both formulations proved to be easy delivery systems for the tested fungal isolates, however, from the economic point of view, the “Pesta” formulation is possibly more appropriate since it is cheaper and easy to prepare. Further research should focus on increasing and stabilising the efficacy of the bioagent under field conditions.

Keywords: Formulation, *Fusarium*, mycoherbicide, parasitic weeds, *Striga hermonthica*

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Compatibility of *Striga*-Mycoherbicides with Fungicides Delivered Using Seed Treatment Technology and its Implication for *Striga* and Cereal Fungal Diseases Control

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Root parasitic weeds of the genus *Striga* and fungal diseases constitute a major biotic constraint to staple food production in Africa, and consequently aggravate hunger and poverty. With the aim of improving sorghum and maize performance and yield, an investigation on the possibility of delivering *Striga*-mycoherbicides (*Fusarium oxysporum* Foxy 2 & PSM197) and selected fungicides using seed treatment technology to control simultaneously *Striga hermonthica* and sorghum and maize fungal diseases was made for the first time. Film-coated seeds of sorghum with different application rates (dosages) of Apron XL and Ridomil Gold in combination with the mycoherbicides Foxy 2 and PSM197 and different coating adhesives were used. The effects of Apron XL and Ridomil Gold fungicides on growth and sporulation of the two isolates was examined by growing the film-coated sorghum seeds on PDA media. Delivering of the fungicides Apron XL and Ridomil with *Striga*-mycoherbicides Foxy 2 and PSM197 using seed treatment technology did not interfere with the seed coating process nor with the initial survival of fungal isolates on coated sorghum seeds. Apron XL clearly enhanced the growth, sporulation and viability of both isolates, indicating strong compatibility with *Striga*-mycoherbicides. However, Ridomil Gold was not compatible on PDA medium. Under field conditions of West Africa, the integration of fungicide Apron XL (at a rate of 0.5ml kg⁻¹ of seeds) with *Striga*-mycoherbicides (Foxy2 & PSM197) and resistant maize cultivars using seed treatment technology and Arabic gum as adhesive showed significant reduction in *Striga* emergence by 81 % and 90 % compared to the respective resistant and susceptible controls. Improved performance of maize treated with *Striga*-mycoherbicides and fungicide by 300 % was further recorded. The compatibility between *Striga*-mycoherbicides and Apron XL fungicide has significant implication for controlling simultaneously *Striga* and sorghum and maize fungal diseases and improving crop performance and yield.

Keywords: Fungal diseases, fungicides, *Fusarium oxysporum*, integrated control, biological control, mycoherbicide, seed coating, *Sorghum bicolor*, *Striga hermonthica*, *Striga*-resistant cultivar, *Zea mays*

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Application of the Endophyte *Piriformospora indica* in Hydroponic Cultures

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Piriformospora indica (Basidiomycota, Sebaciales) is a root endophytic fungus with a broad host spectrum. *P. indica* colonizes the cortex of roots, promotes plant development and induces resistance against fungal pathogens. In the present investigation it was aimed to analyse, if this endophyte also interferes with Pepino mosaic virus (PepMV) infection of tomato — a serious problem in soilless cultures world wide. However, all investigations for the influence of the fungus on plants have been up to now carried out in pot cultures where seedlings were inoculated upon planting. Because experiments using the model cultivar ‘Hildares’ showed that the time point of inoculation had only slight influence on the plant growth promoting effect, the application of *P. indica* could be examined in hydroponic cultures. Tomato plants were grown in a hydroponic system under standard conditions and inoculated after nine weeks with *P. indica* spores or hyphae from two different culture media. Colonisation of the roots was monitored after trypan blue staining and plant growth parameters were estimated. The experiments showed that the inoculum strongly influenced the spread of the fungus inside the root, but not the increase in root and shoot fresh weight. In a second set of experiments, the interaction between two isolates of PepMV and a number of tomato cultivars from Syria, Europe and USA were tested. Results revealed no difference in susceptibility indicating that the cultivar ‘Hildares’ can be used as model for further analyses of *P. indica* — PepMV - tomato interactions.

Keywords: Hydroponics, Pepino mosaic virus, *Piriformospora indica*

Index of Authors

A

- Abaidoo, Robert 185
- Abbasher, Abbasher Awad
..... 524
- Abdalla, Muna Ali ... 156
- Abdalla, Sahar 366
- Abdelmula, Awadalla Ab-
dalla 440,
453
- Abdelwahab, Abdelhadi
..... 476
- Abu Shaban, Ahmed . 477
- Abuanja, Ishraka Khamis
..... 440
- Acedo, Antonio 497
- Acuña Azarte, Magally
..... 294
- Adam, Adam 488
- Adam, Hassan Elnour 256
- Adanguidi, Jean 122
- Adarkwah, Charles .. 503
- Adebayo, Ayodeji 31
- Adeduntan, Sunday .. 221
- Adeniran, Kamoru .. 168,
468
- Adesehinwa, Akinyele
Oluwatomisin
Kingsley ... 31
- Adeyemo, Gbemiga ... 28
- Adeyemo, Remi 179
- Adhikary, Sujit . 443, 452
- Aduramigba-Modupe, Vin-
cent
..... 457
- Agbede, J. Oluwasola . 29
- Agbetoye, Leo 93
- Aguirre Calderon, Oscar Al-
berto
..... 277
- Agus, Fahmuddin ... 471
- Ahmad Reza, Mehrabian
..... 237
- Ahmadi, Hasan 392
- Ahmed, Elamin Ali .. 524
- Ahmed, Elgilany A. . 441,
478
- Aigelsperger, Lisa ... 127
- Aiyelaagbe, Isaac ... 470
- Ajibolu, Idowu 196
- Akaranuchat, Piyachat
..... 521
- Akinnagbe, Akindele 223
- Akinola, Adebayo ... 179
- Akintayo, Lawal 28
- Alamirew Chekol, Dilne-
saw
..... 358
- Alcaraz V., Gabriela . 365
- Alene, Arega 179
- Aletor, V. Ayobore 29
- Ali, Abbas Hassan ... 236
- Ali, Ali 502
- Aliarab, Alireza 490
- Almohamed, Salwa .. 364
- Alonge, Folarin ... 85, 97
- Altieri, Miguel 8
- Alzérreca, Humberto .. 23
- Amdur, Liron 326
- Amend, Joerg 196
- Amoah, Philip 461
- Amusan, Olusola Aduke
..... 403
- Amusan, Opeyemi Anthony
..... 403
- Angulo, Lenkizza ... 209
- Apichartsrungkoon, T. 32,
74
- Arahalli Venkataronappa,
Manjunatha
..... 339, 463
- Araremme, Daba Feyisa
..... 487
- Arias Giraldo, Ligia Maria
..... 282
- Arias, Adriana 420
- Arsanti, Idha Widi ... 105
- Asch, Folkard .. 354, 446,
448–451
- Asiedu, Robert 408
- Aung, Tam 450
- Aung, Tin 53
- Avocanh, Adolphe ... 525
- Awad Kheiry, Manal . 362
- Ayalew, Workneh 68
- Ayana, Temesgen 68
- Ayenew, Yitaye Alemayehu
..... 52
- Azizi, Reza 255

B

- Babatunde, Oludare . 168
- Babiker, Abdulkhalig . 24,
43
- Bahar, Habibullah 56
- Bahta, Sirak 131

- Bandte, Martina 509, 511, 526
- Banout, Jan . 88, 257, 310
- von Bargen, Susanne 509, 511, 526
- Barkmann, Jan . 189, 323, 329, 343
- Barral, Stephanie 104
- Bartl, Karin 57
- Bauer, Siegfried 116, 131, 169, 181, 186, 249, 360
- Beck, Stephan 23
- Becker, Klaus 36, 99
- Becker, Mathias 448–451
- Beckmann, Volker . . . 334
- Behl, Rishi Kumar . . . 519
- Belli, Henderiana 22
- Bellon, Mauricio 245
- Beran, Franziska 443
- Bercher-Hiss, Susanne 133
- Berg, Christian 133
- Berger, Nils 303, 311
- Bernal, Laila C. 17
- Bernard, Lehmann 76
- Bertke, Elke 326
- Bertzky, Monika 232
- Bessei, Werner 20
- Bett, Eric 228
- Beyersdorff, Undine . . 265
- Bhandari, Netra 250, 253, 270
- Bij de Vaate, Marije D. 341
- Binder, Claudia R. . . . 117, 371
- Blanchard Ortiz, Gentiane 401
- Blievernicht, Armin . . 510
- Blume, Frank 206
- Bode, Reinhild 128
- Bögeholz, Susanne . . . 343
- Böhme, Michael 105
- Böhnel, Helge 24
- Börner, Andreas 446
- Bollati Hurtado, Guido 293
- Boonnoul, Supasid . . . 71
- Boonruang, Phaktema . . 33
- Bordoni, Paul 246
- Bouman, Bas 484
- Braun, Mathias 193
- Brenig, Bertram 74
- Brice, Sinsin 45, 227, 405
- Brinkmann, Katja . . . 394
- Brookes, Phil 404
- Brümmer, Bernhard . . 111
- Brune, Thomas 407
- Brush, Stephen B. . . . 231
- Buck-Sorlin, Gerhard H. 446
- Budjurova, Evelina . . . 116
- Bülbül, Mehmet 395, 426
- Buerkert, Andreas . . 42, 89, 157, 167, 216, 357, 366, 368, 394, 402, 413, 436, 483, 489
- Buettner, Carmen 499, 502, 503, 509–512, 526
- Burgess, Stephen 373
- Burkard, Günter 107, 108
- C**
- Cadisch, Georg 119, 315, 353, 386, 389, 400, 407, 471, 473, 485, 525
- Callo-Concha, Daniel 347
- Camargo, Juan Carlos 264, 282
- Campos, Adriana 410
- Cantú Silva, Israel . . . 275, 276
- Caycho, Jorge 420
- Cedeno, R. 291
- Ceniza, Maria Juliet C. 501
- Chakeredza, Sebastian 71
- Chaboussou, Anne . . . 401
- Chaliganti, Raghu . . . 312
- Charoensook, Rangsun 74
- Cheerawat, Khemsawat 72
- Chen, Lu 152
- Chen, Yuanquan 327
- Chengappa, P.G. 463
- Chikoye, David 185
- Chirwa, Michael 265
- Cho, Khin Mar 138
- Chongkasikit, Nattaphon 32, 75
- Choocharoen, Chalathon 304
- Chuong, Sophal 486
- Clément, Céline 41
- Claupein, Wilhelm . . . 308
- Clemens, Joachim . . . 307
- Cobo, Juan Guillermo 119
- Corre, Marife D. 273
- Coulibaly, Yacouba . . . 325
- Coutinho, Heitor 112
- Cruz, Aletheia Ferreira Da 305
- Cruz, H. 54
- Cuervo, Sandra Patricia 94
- D**
- Dabbert, Stephan 348
- Dalle, Gemedo 314
- Dannenmann, Barbara M. E. 304
- Daouda, Dao 76
- Dare, Michael 408
- Darvishsefat, Ali Asghar 279
- Davidsson, Lena 159
- Dawelbeit, Shama . . . 447
- De Boer, Imke Johanna 40

- De Caluwé, Emmy . . . 238
 De Cruz, Felipe 245
 De Groote, Sitske . . . 238
 De Korte, Edwin 513
 Delve, Robert 119
 Denich, Manfred 347
 Dercon, Gerd . . . 119, 315,
 386, 389, 400,
 471, 485
 Deressa, Abdenna . . . 434,
 474
 Dewi, Sonya 315, 386
 Dheeranupattana, Srisulak
 517
 Dickhoefer, Uta . . 42, 394
 Didonet, Agostinho Dirceu
 456
 Dillon, Juan Rodríguez
 289
 Diogo, Rodrigue 436
 Diop, Abdallah 110
 Distel, Andreas . . 386, 471
 Dong, Xiaobin 327
 Donovan, Jason . . 130, 201
 Doppler, Werner . . 58, 364,
 472, 477
 Dornberger, Utz 173
 Dossman Gil, Miguel An-
 gel
 282
 Dosso, Mireille 401
 Drechsel, Pay 461
 Drucker, Adam 73
 Duc Vien, Tran 353
 Duduyemi, Olubunmi Ay-
 obami
 155
 Dukhovny, Victor . . . 376
 Dung, Bui 36
- E**
- Ebong, F. 59
 Egelying, Hendrik . . . 187
 Eggers, Jörg 334
- Eguavoen, Irit 466
 Ehlert, Christoph 172
 Ehringhaus, Christiane
 266
 Eisa, Maymoona Ahmed
 504
 Ejobi, F. 59
 Ekadinata, Andree . . . 315
 El Hassan, A.E. 504
 El Owni, Osman Ali . . 55
 El Sanousi, Sulieman . . 43
 El Tinay, Abdullahi H.
 156
 El Zubeir, Ibtisam E. M.
 55
 El-Siddig, Kamal 357,
 366
 Elamin, M.E. 504
 Elazegui, Francisco . . 484
 Elbadawi, Ali 504
 Elfadl, Elfadl 444
 Elgali, Mohamed Babekir
 169
 Elhagwa, Abdalla . . . 469
 Elmobarak, Abdelmagid
 476
 Elobeid, Hashim A. . . 478
 Elsheikh Mahmoud, Tarig
 362
 Eltom, Kamal Eldin Hassan
 Ali 24, 43
 Elzein, Abulegasim . . 525
 Em, Sotheara 160
 Encinas, Felix 23
 Engel, Stefanie 302
 Erasmí, Stefan . . . 356, 377,
 388
 Erenstein, Olaf 120
 Esch, Elisabeth 433
 España, Mingrelia . . . 407
 Euloge Brice, Dongmeza
 36
- F**
- Fadul, Moiez 366
 Fagbola, Olajire 408, 439,
 455
 Fakhro, Ahmad 526
 Faki, Hamid H.M. . . . 478
 Faronilo, Jamie 484
 Fasinminrin, Johnson . . 98,
 465
 Fatehi, Parviz 279
 Faust, Heiko 189, 388
 Fayose, Olawole J. . . 442
 Feghhi, Jahangir 255
 Feike, Til 308
 Fell, Martina 133
 Fen, Beeden 525
 Feola, Giuseppe 371
 Fernández Cusimamani,
 Eloy . 165, 240
 Fernandez, Luzviminda
 484
 Ficarelli, Pier Paolo . . 194
 Fichtler, Esther 283
 Finckh, Maria Renate 515
 Finkeldey, Reiner . . . 223,
 272
 Focken, Ulfert 36
 Foljanty, Karin 192
 Formowitz, Beate . . . 413
 Foshat, Mahboobeh . . 254
 Franken, Philipp 526
 Freyer, Bernhard 184, 219,
 228
 de Freitas, Antonio Carlos
 Reis 259
 Frickmann Young, Carlos
 Eduardo . . 295
 Fritz-Vietta, Nadine . . 232
 Frömberg, Herbert . . . 195
 Fromm, Ingrid 173
 Fuwape, Joseph 221
- G**
- Gómez Meza, Marco V.
 275, 276

- Gabagambi, Damian M. 174
- Gaese, Hartmut . 322, 363
- Gailing, Oliver . 223, 272
- Gaiser, Thomas 376
- Ganawa, Ettayeb 361
- Gandini, Gustavo 73
- Gangurde, Sarwshri . 501
- Gao, Wangsheng 327
- García Sierra, Jorge Hugo 282
- Garcia, Otto 378
- Garming, Hildegard . 498
- Gast, Fernando 195
- Gatphayak, Kesinee . . 32, 33, 74
- Gauly, Matthias 62
- Gayen, Sankar 443
- Ge, Jiwen 390
- Gebauer, Jens . . 216, 236, 357, 366, 368, 402, 483, 489
- Gedamu, Ashenafi . . . 171
- Gehring, Christoph . . 259
- Geissen, Violette 412
- Genova, Christian . . . 497
- Georgiadis, Pavlos . . . 233
- Gerhards, Roland 220
- Gerhardt, Norman 63
- Germer, Jörn 84
- Gessler, Frank 24
- Getaneh, Fite . . . 434, 474
- Getu, Emana 507
- Gibreel, Tarig . . 186, 249
- Gichangi, Elias 404
- Glenk, Klaus 343
- Godjo, Thierry 100
- Göltenboth, Friedhelm 501
- Götz, Klaus-Peter 38
- Gomez, Carlos A. 57
- González Rodríguez, Humberto 25, 275–277
- González, M. 291
- Gonzalez Azcarraga, Juan Carlos 87
- Gonzalez Tagle, Marco Aurelio 277
- Good, Stephanie 159
- Gordon, André 163
- Goshu, Tolera Abera . 487
- Goswami, Arunava . . 443, 452, 510
- Gotschi, Elisabeth . . . 184
- Grass, Martin 301
- Grötz, Patrick 183
- Grote, Ulrike . . . 113, 175
- Guerra, M. 291
- Guimaraes Callado, Sandra Maria 225
- Gunawan, Dodo 374
- Guo, Jianchun 380
- Guthiga, Paul 281
- H**
- Habasimbi, Kennedy . 309
- Habibi Bibalani, Ghassem 338
- Habte, Ermias 200
- Haeusler, Charlotte . . 193
- Haesungcharoen, Methinee . 86, 87, 90, 309
- Hago, Tag El-Din E. M. 438
- Hammer, Karl . . 234, 237, 402
- Hardeweg, Bernd 106
- Hauser, Michael 127, 132, 207
- Hauser, Stefan 454
- Havrland, Bohumil . . 144
- Heidhues, Franz 118
- Heinrich, Jürgen 317
- Heller, Joachim 218
- Helming, Katharina . . 112
- Hemme, Torsten 378
- Henniger, Thomas . . . 509
- Hensel, Oliver . 83, 89, 94, 157
- Herberg, Lea 193
- Hergarten, Marion . . . 265
- Herrero, Mario 67
- Herrmann, Ludger . . . 368
- Hertel, Maja 485
- Herzog, Helmut 432
- Hess, Hans-Dieter . 17, 57
- Hidalgo, Glida Gisela 291
- Hijawi, Thameen 462
- Hilger, Thomas . 353, 400, 473, 485
- Hirschnitz, Martin . . . 232
- Hobinka, Alexander . 133
- Hodgkin, Toby 341
- Hörstgen-Schwark, Gabriele 39, 53
- Hoeschle-Zeledon, Irmgard 246
- Hoffmann, Andreas . . 499
- Hoffmann, Volker . . . 61, 183, 215, 233, 253, 424
- Holikova, Petra . 114, 144
- Holm-Müller, Karin . 281, 328
- Holmann, Federico 54, 57
- Holtz, Wolfgang 22
- Houssou, Nazaire S. I. 365
- Hülsebusch, Christian . 63, 69
- Huenchuleo, Carlos . . 324
- Huni, Samson 432
- Hurrell, Richard 159
- I**
- Idinoba, Monica 325
- Idowu, John 457
- Innocent, Ndoh Mbue 390
- Insung, Ong-Arge . . . 224

- Intarini, Dian Yusvita 386,
389
- Isabirye, P. 59
- Islam, Monirul 56
- Islam, Tarikul 56
- Issakul, Kritchaya ... 505
- Iyayi, Eustace Ayemere
..... 26
- J**
- Jafari, Mohammad ... 30,
391, 392
- Jahnke, Hans E. 105
- Janjai, Serm ... 86, 87, 90
- Janke, Julia 511
- Jankowski, Anna 500
- Janss, Luc L.G. 70
- Janßen-Tapken, Ulrike 70
- Janssens, Marc J. J. . . 152,
225, 284
- Jatisatienr, Araya 505,
517, 518
- Jatisatienr, Chaiwat . . 505,
517, 518
- Jaturasitha, Sanchai ... 32,
71, 72
- Jekayinfa, Simeon Olatayo
..... 306
- Jelantik, I. Gusti Ngurah
..... 22
- Jihong, Li 152
- Jimenez Perez, Javier 277
- Joachim, Vogt 45
- Joergensen, Rainer Georg
..... 411, 413
- Johannsen, Julia 365
- Johnson, James 252
- Jores, Joerg 44
- Joshi, Laxman . . 315, 386,
389, 471
- Joshi, Nirmala 243
- Joudi, Lila 338
- Juhrbandt, Jana 189
- Jun, He 335
- Junge, Birte 185
- Juroszek, Peter 418
- K**
- K. C., Krishna Bahadur
..... 387, 472
- K. C., Rajendra . 250, 253
- Kærgård, Niels 187
- Kabakeris, Theresa .. 452
- Kabasa, John David ... 59
- Kabirizi, Jolly 50, 59
- Kadarmideen, Haja N. 70
- Kambouzia, Jafar 409
- Kandeler, Ellen 407
- Kaplan, Marcus 385
- Kappas, Martin . 356, 377,
393
- Karamura, Eldad 523
- Karimou Jean Marie, Am-
bouta 227,
405
- Kaufmann, Brigitte 69, 77
- Kaushik, Geetanjali . . 153
- Ke, Youpeng 380
- Keding, Gudrun B. . . 217
- Kehlenbeck, Katja ... 243
- Keil, Alwin 374
- Kelarestaghi, Adel ... 392
- Keraita, Bernard 461
- Keutgen, Anna . 166, 425
- Khafagi, R.M. 504
- Khair, Mohamed Ahmed
..... 476
- Khan, Ikhlas Ahmad .. 41
- Khan, Mohammad Asif
..... 103
- Khatab, Abdelgader H.
..... 156
- Khoshbakht, Korous . 234,
237
- Kien, T.T. 353
- Kilcher, Lukas 417
- Kindermann, Matthias 96
- Kiplagat, Andrew K. . 251
- Kirchhoff, Joachim .. 270
- Kirschke, Dieter 512
- Kitchaicharoen, Jirawan
..... 472
- Klein, Alexandra-Maria
..... 388
- Kleinn, Christoph ... 250,
264
- Kleisinger, Siegfried .. 99
- Kloas, Werner 19
- Kluth, Holger 26
- Knerer, Béatrice . 134, 244
- Knorr, Christoph 74
- König, Hannes 112
- Kohlmeyer, Christoph 192
- Kongkaew, Thanuchai 400
- Koocheki, Alireza ... 222
- Krasachat, Wirat 60
- Kratzeisen, Martin 82
- Krause, Michael 261
- Krawinkel, Michael .. 217
- Kreuzer, Michael . 17, 23,
41, 57
- Kreye, Christine 484
- Kriesemer, Simone .. 183
- Krittigamas, Nattasak 521
- Krivankova, Blanka .. 310
- Kroschel, Jürgen 525
- Kruijssen, Froukje ... 245
- Kühl, Rainer 150
- Kulik, Michal 88
- Kumphakarm, Ratchanee-
wan
..... 74
- Kutter, Thomas 508
- Kyambadde-Kyeyune,
Ahmed ... 202
- L**
- Lachman, Jaromír ... 165,
240
- Lagat, Job 228
- Lage, Elisangela de Al-
buquerque So-

- breira
..... 154
- Lage, Moacir Evandro
..... 154
- Laiprawat, Supalerk .. 74
- Langenberger, Gerhard
..... 218
- Langensiepen, Matthias
..... 373
- Langkau, Maike 167
- Lapsongphol, Saranya 90
- Lascano, Carlos ... 17, 61
- Laso Bayas, Juan Carlos
..... 315, 386
- Laurent, Houessou 45
- Le, Quang Bao 385
- Leawtharakul, Amnuay 71
- Leek, Kendra 207
- Leis, Hermann 86, 87, 90,
309
- Lelei, Joyce 219
- Lemma, Zemedu 328
- Lentes, Peter 54
- Leonhäuser, Ingrid-Ute
..... 181
- Leopold, Aaron 467
- Liaghati, Houman ... 142,
406
- Liasu, Mojeed 516
- Lippe, Melvin .. 353, 473
- Lippert, Christian 96
- Lis Gutierrez, Jenny Paola
..... 292
- Liu, Yan 380
- Llorca, Lizzida 484
- Locher, Nicole Milena 41
- Löhr, Bernhard 500
- Lojka, Bohdan ... 88, 257,
310
- Lojkova, Jana ... 88, 257,
310
- Longe, Oyebiodun 28
- Loos, Heinz 202
- Lopez, Fernando 290
- Lucena Friederich, Ivone
Gorete ... 137
- Lucien, Fotso 393
- Lücke, Wolfgang ... 520
- Luedeling, Eike 216, 357,
366, 402
- Luetzger, Andrea B. .. 519
- Lusembo, Peter 202
- Lusiana, Betha . 386, 389
- ## M
- Ma, Chin-Hua 418
- Maass, Brigitte L. ... 217,
243
- Mac-Knight, Vivian . 295
- Madaleno, Isabel Maria
..... 263
- Maeder, Paul 417
- Mahayothee, Busarakorn
86, 87, 90, 309
- Mahdavi Damghani, Abdol-
majid 222,
422
- Mahmoudi, Hossein . 142
- Maleknia, Rahim 254, 255
- Malik, Anushree 153
- Mandour, Mohamed . 367
- Manrique, Ivan 41
- Manske, Günther 519
- Marcuzzo, Francisco . 464
- Margraf, Josef 218
- Marley, Paul 525
- Marohn, Carsten 315, 386,
389, 471
- Marquardt, Svenja 23
- Martin, Konrad 501
- Martin, Nicola 466
- Martius, Christopher . 399
- Marx, Friedhelm 163
- Matanmi, Opes 30
- Mathijs, Erik 372
- Max, Johannes 81
- Mayer, Andrea Corinna
. 23, 40, 41, 57
- Maza, Byron 375
- Mburu, John 251, 281
- Medina, Gabriel 252
- Mehring, Marion 232
- Meireles, Ana Luiza . 295
- Meke, Gerald 265
- Mekuria, Mulugetta . 118
- Mekuria, Wolde 274
- Melo Carvalho, Marcia
Thais 456
- Mergenthaler, Marcus . 77
- Mesquita, Albenones José
de 154
- Mettepenningen, Evy 334
- ter Meulen, Udo .. 21, 32,
33, 62, 71, 75
- Mewis, Inga 499, 510
- Meyer, Uwe 315, 386, 471
- Michel, Dumondel 76
- Mihara, Machito 414
- Mika, Irma 265
- Mikled, Choke 21
- Milella, Luigi .. 165, 240
- Mimler, Matthias 388
- Min, Htut Yin 204
- Mirarab, Javad 254
- Mirzaei Talarposhti, Reza
..... 409
- Missagia, Bruna 258
- Mitchell, Patrick 373
- Mithöfer, Dagmar ... 172,
500
- Mitterbauer, Esther .. 433
- Mnkeni, Pearson 404
- Mohamed, Abubakr . 441
- Mohamed, Khaled 37
- Mohamed, Mahasin Ali
..... 476
- Mohammadi, Jahangarad
..... 136, 490
- Mohammed, Afrah .. 425
- Monje, Coral 119
- Moonsikeaw, Sonthaya 21
- Moraes, Arlete 303

- Moreira, Jose Aloisio Alves
..... 456
- Mosandl, Reinhard .. 235
- Mpairwe, Denis 50
- Masukwa, Violet 265
- Müller, Torsten . 445, 481,
482, 514
- Mueller, Joachim
..... 82, 86, 87,
90, 96, 304, 308,
309
- Müller, Ulrike 133
- Müller-Stöver, Dorette
..... 524
- Mugendi, Daniel 251
- Muhunyu, Samuel ... 203
- Mullik, Marthen Luther
..... 18
- Mund, Jan-Peter 260, 359
- Munir, Anjum 83
- Musa, Nasreen Omer . 24,
43
- Mushinzimana, Godihald
..... 121
- Mustafa, Rajaa 169
- Mutetikka, David 50
- Muthomi, James W. . 522
- Mutwiwa, Urbanus N. . 81
- Muuss, Uwe 270
- Mwangi, Maina 523
- Mysore, Chandrakanth
..... 109, 463
- N**
- Nabheerong, Pensiri . 226
- Nagieb, Maher 402
- Nagle, Marcus 86, 87,
304, 309
- Naik, Satyanarayan .. 153
- Nair, Balakrishnan ... 239
- Namiranian, Manoochehr
..... 255, 279
- Nankinga, Caroline .. 523
- Narayana, Rashmi ... 109
- Nareppa, Nagaraj 463
- Naseri, Hamid Reza . 391
- Ndambi, Oghaiki Asaah
..... 378
- Nduma, Immaculate Njuthe
..... 181
- Ndungu-Skilton, Julia 341
- Neef, Andreas 304
- Negassa Chewaka, Wakene
..... 434, 474
- Nehls, Thomas 206
- Nehren, Udo 317
- Neidig, Ralph 39
- Neth, Baromey . 134, 244
- Nettleton, John 138
- Neumann, Günter ... 514
- Ngereza, Andrew 166
- Nguyen Tien, Hai ... 278
- Nguyen Van, Dai 20
- Nhamo, Nhamo 399
- Njuki, Jemimah 127
- Nkem, Johnson 325
- Noimancee, Pichet ... 521
- Nolten, Ralf 137
- van Noordwijk, Meine
. 315, 386, 389,
471
- Norkeaw, Rakkeart ... 72
- Notenbaert, An 67
- Nowotnick, Beatrice . 208
- Nsiah, Bernard 285
- Nthenda, Ustanzious . 265
- Nuß, Philipp 99
- Nwosu, C. 34
- Nyunt, Khin Thein .. 506
- O**
- Obeng-Ofori, Daniel . 503
- Obi, Olumide Olutayo 31
- Önal, M.kubilay 161, 162
- Ofongo, Seimiyenkumo
Taria 27
- Ofuya, Thomas 221
- Ogungbe, Peter Wusu 455
- Ogunji, Johnny Onyema
..... 19, 34
- Oguntunde, Philip 98,
403, 465
- Oje, Kayode 97
- Ojo, Oladunni Ayoola 439
- Olaniyan, Adesoji 97
- Oliveira, Priscila de ... 51
- Ologhobo, Anthony D. 27
- Olowu, Olufemi P.a. . 29
- Oltchev, Alexander .. 388
- Olufayo, Mosun 35
- Olukunle, Olawale John
..... 91, 92, 95
- Olukunle, Oluwatoyin Fo-
lake
..... 91
- Omitogun, Galman .. 155
- Ongprasert, Somchai 482,
491
- Oniya, Olaoluwa 85
- Onwonga, Richard ... 219
- Onyekwelu, Jonathan C.
..... 235, 442
- von Oppen, Matthias . 115
- Orodele, Oluwaseyi .. 470
- Oscar, Teka 45
- Osugwe, Donald I 34
- Oswald, Andreas 420
- Otto, Marco 206, 355
- Otunola, Ezekiel Tejumola
..... 151
- Oyeneye, Oladipo 93
- P**
- Pacesny, Jiri 114
- Padgham, Jon 449
- Padungtod, Pawin 33
- Pagel, Thilo 19
- Palada, Manuel C. ... 418
- Palanisami, K. 381
- Palmer, Charles 302
- Pampasit, Savent 226
- Pananurak, Piyatat ... 205

- Panfyorov, Oleg 377
 Pansak, Wanwisa 400
 Papagiannopoulos,
 Menelaos . 163
 Parameswaran Pillai,
 Anoop ... 321
 Pariyar, Shyam 307
 Pattanapo, Wanwarang
 520
 Paudel, Lok Nath 62
 Pawelzik, Elke . 166, 176,
 242, 425, 505,
 517, 518
 Peña Peña, Karina ... 412
 Pedroso, Rui ... 322, 363
 Pems, Diemuth 180, 188
 Peters, Michael ... 54, 61
 Peyvast, Gholamali .. 437
 Pham, Thi Mai Huong 77
 Phonbumrung, Thum-
 rongsakd
 72
 Phuapachitkun, Sarawut
 87, 90
 Pichpol, Duangporn .. 33
 Piechaczek, Jürgen .. 128
 Piepho, Hans-Peter ... 69
 Pillot, Didier 199
 Pinos Barreto, Susy Alejan-
 dra
 215
 Pirintra, Prapawadee .. 33
 Pletziger, Stefan 148
 Pocasangre, Luis 508
 Pohlan, Jürgen .. 152, 284
 Pokorny, Benno 252
 Polesny, Zbynek . 88, 257,
 310
 Ponce Aguirre, Dante . 41
 Poncet, Elsa 104
 Pongthornpruek, Supaporn
 226
 Poole, Nigel 130
 Prakash, Siddharth .. 133
 Praneetvatakul, Suwanna
 106, 205
 Predotova, Martina .. 368
 Preininger, Daniel ... 310
 Pretzsch, Jürgen 204, 271,
 285
 Priess, Jörg A. 388
 Printz, Andreas 376
 Pripwai, Nakarin 75
 Promtep, Kongsakdi . 226
 Propastin, Pavel 356, 377,
 393
 Prozell, Sabine 503
 Puspa, Jofi 150
 Puthiyapurayil Changat,
 Deepesh .. 339
- ## Q
- Quek, Paul 245
 Quiroz, Roberto 209
- ## R
- Rabie, Tarik 367
 Rahman, Mohammad Az-
 izur
 475
 Rajaona, Arisoa Mampi-
 onona
 225
 Rakotoarisoa, Manitra 67
 Ramírez Lozano, Roque G.
 .. 25, 275, 276
 Randolph, Thomas .. 159
 Rao, V. Ramanatha .. 245,
 435
 Rawat, Gopal S. 233
 Rayhan, Israt 113
 Reckling, Moritz 489
 Reiber, Christoph 61
 Reichmuth, Christoph 503
 Renaud, Fabrice 385
 Reversat, Georges ... 484
 Ribeiro, Maria Miguel
 132
 Ricardo, Tiago Ribeiro 51
 Richter, Christian ... 110,
 447, 469, 476
 Richters, Jan 355
 Riedel, Simon 68
 Rijal, Baburam . 250, 253
 Rith, Sam Ol 134
 Riungu, Ginson M ... 522
 Riveros, Alba Stella . 508
 Rodehutschord, Markus 26
 Rodrigues, Roberta B. 163
 Roehrig, Jackson 358,
 361, 475
 Römheld, Volker 445, 481,
 482, 514
 Rohrbach, Jana 265
 Roman, Franz 86
 Rosales, Franklin E. . 508
 Roth, Ivonne 510
 Roth, Mechthild 504
 Rousova, Barbora ... 257
 Rovayo Andrade, Maria A.
 289
 Roygrong, Sithidech . 481,
 482
 Rueda Ayala, Victor Patri-
 cio
 220
 Ruiz, Javier David Sosa
 259
 Rupp, Johannes 342
 Rupschus, Christian . 512
- ## S
- Sánchez, Elsa 58
 Sabahi, Hossein 406
 Sabel, Salih Adam Ibrahim
 453
 Safrizal, Safrizal 514
 Saied, Amina 483
 Saifullah Khan, Khalid
 411
 Sajise, Percy 245
 Salehi, Azadeh . 136, 490

- Salman, Amer Z. 462
 Samaddar, Arindam . 120
 Sandwidi, Jean-Pierre 466
 Sann, Vathana .. 160, 486
 Santana, Ricardo Felix
 288
 Santos, Norma Ely .. 140,
 141
 Satya, Santosh 153
 Sauerborn, Joachim ... 84,
 501, 524
 Sawatwanich, Auntika
 517
 Saxena, Shilpi 423
 Schippers, Björn 189
 Schlecht, Eva
 .. 42, 157, 167,
 368, 394, 436
 Schliep, Rainer 232
 Schlüter, Sabine 322, 363
 Schmidlein, Sebastian
 280
 Schmitt, Julia 424
 Schmitter, Petra 485
 Schneider, Eva Maria 323
 Schoell, Regina 117
 Schöllner, Matthias ... 503
 Scholz, Volkhard 306
 Schreiter, Jennifer Linn
 218
 Schröder, Hilmar 508
 Schütt, Marianne 445
 Schultze-Kraft, Rainer 61,
 215
 Schulz, Carsten ... 19, 38
 Schumacher, Joerg .. 157,
 357
 Schwarz, Dietmar ... 526
 Schwarze, Stefan
 . 189, 323, 336,
 365, 388
 Seeberg-Elverfeldt,
 Christina . 336
 Sermann, Helga 502
 Sertac, Gönenc 395
 Sessouma, Alexandre 466
 Shapo, Haider 488
 Sharma, Kalpana 515
 Shechter, Mordechai . 462
 Shibru, Simon 314
 Shiferaw, Bekele 381
 Shiferaw, Yoseph 159
 Shiva, Vandana 233
 Shresta, Suchit 448
 Shuiep, El Tahir Salih . 55
 Siddig, Khalid .. 360, 441
 Sieber, Stefan 112
 Sietz, Diana 209
 Sikora, Richard A. ... 449
 Silva Junior, Renato Pinto
 Da 305
 Silva, Rodrigo 324
 Silveira, Pedro Marques da
 51
 Simasatikul, Nucha ... 32,
 33, 71, 74, 75
 Simtowe, Franklin ... 143
 Sinclair, Fergus L. ... 269
 Siritwattananon, Lalita 414
 Siziba, Shephard 118
 Slawski, Hanno 38
 Sobhe Zahedi, Shahriar
 338
 Sohail, Muhammad .. 483
 Sok, Seyha 359
 Solademi, Aderonke
 Oluwatoyin
 151
 Somsak, Wiwat 242
 Sosa, G. 291
 Soyka, Tamara 302
 Sperling, Frank 209
 Spoerry, Sylvie 401
 Spreer, Wolfram 304, 481,
 482
 Sprenger, Torsten 316
 Srean, Pao 486
 Srinivasa Gowda, M.V.
 109
 Sriprang, Nimit 226
 Sruamsiri, Pittaya ... 481
 Stahr, Karl 376
 Stamer, Andreas 39
 van de Steeg, Jeannette 67
 Stefenon, Valdir Marcos
 272
 Steinbronn, Silke 36
 Stellmacher, Till 175
 Stephan, Nina 265
 Sthapit, Bhuwon 245, 435
 Stimm, Bernd 235
 Stoian, Dietmar . 130, 201
 Stoll-Kleemann, Susanne
 232
 Stolz, Tobias 196
 Stürz, Sabine 451
 Stumpf, Elmar 82
 Sulieman, Saad Abdel Rahman
 438
 Sunny-Roberts, Elizabeth
 Oluwaseun
 151, 158
 Suryaprakash, S. 321
 Suyamto, Desi 389
 Swamikannu, Nedumaran
 381
 Szarzynski, Joerg 379
- ## T
- Tabari, Masoud . 136, 490
 Taesoongnern, Sumalee
 74
 Taha, Mohamed Elnour
 256
 Tahmoures, Mohammad
 391, 392
 Tanrivermis, Harun .. 395,
 426
 Tantau, Hans Jurgen .. 81
 Taubert, Barbara 271
 Tegegne, Azage 52

- Terre, Sunilda 449
 Tesfai, Sahle ... 203, 421
 Tesfaye, Teklu 337
 Tessema, Taye 499,
 509–512
 Teufel, Nils 120, 374
 Thanapornpoonpong, Sa-
 nguansak . 176,
 242
 Thamrin, Tanty S. ... 135,
 340
 Theanjumpol, Parichat
 176
 Thierfelder, Christian 399
 Thobunluepop, Pitipong
 517, 518
 Thomas, Frédéric 284
 Tia, Lazare 280, 379
 Tiemann, Tassilo 17
 Tiessen, Holm 410
 Tihune, Asfaw 421
 Tipilda, Annita 187
 Tisch, Christine 445
 Tollens, Eric 372
 Tongruksawattana, Thong-
 porn
 188
 Topcuoğlu, Bülent ... 161,
 162
 Torrico, Juan Carlos . 322
 Touch, Visalsok . 486, 513
 Tran Van, Do 262
 Tröger, Katharine 89
 Tsai, Hsing-Hua 418
 Tscherning, Karen ... 112
 Tuan, Nguyen Ngoc . . 36
 Tung, Phung Duc 106
 Turagij, Rujirak 32
- U**
- Uibrig, Holm ... 261, 278
 Ulrichs, Christian
 . 443, 452, 499,
 509–512
- Uvalle Saucedo, José Isidro
 275
- V**
- Valle Zárate, Anne 69, 77
 Valdivia, Corinne 209
 Valdivia, Roberto 209
 Valentin, Kindomihou 45,
 227, 405
 Van Damme, Patrick . 238
 Van Dung, Nguyen . . 353,
 473
 Van Looy, Tinne 372
 Vassanacharoen, Pratchaya
 520
 Vearasilp, Suchada . . 176,
 242, 505, 517,
 518, 520, 521
 Vearasilp, Therdchai . 21,
 32, 72, 75
 Veldkamp, Edzo 273
 Vera Cruz, Casiana . . 484
 Verner, Vladimir 114
 Vidal, Stefan 506
 Viehmannová, Iva ... 165,
 240
 Vieira, Arimar Leal . . 259
 Vien, Tran Duc . 473, 485
 Vilei, Sonja 348
 Villalobos, Pablo 324
 Virchow, Detlef . 170, 217
 Vlek, Paul L. G. 280, 347,
 379, 519
 Volkmann, Jörg 175
 Von Hörsten, Dieter . 521
- W**
- Wachendorf, Michael . 63
 Wagacha, John M ... 522
 Waibel, Hermann ... 106,
 172, 180, 188,
 205, 498, 500
 Wakene, Negassa Chewaka
 487
- Wall, Patrick C. 399
 Wander, Alcido Elenor 51,
 154, 305, 456
 Wani, Suhas P. 312
 Warui, Harun 69
 Weidner, Annette 446
 Weinberger, Katinka . 497
 Weinmann, Markus . . 514
 Weis, Kevin 96, 308
 Wendland, Edson 464
 Wenzel, Walter 219
 Wessels, Stephan ... 39, 53
 Weyerhaeuser, Horst . 335
 White, Douglas . . 54, 207
 Wick, Barbara . . 410, 508
 Wicke, Michael ... 71, 72
 Wiesner, Melanie ... 499,
 510
 Wifag, Hassan Mahmoud
 361
 Wilfried, Pestemer ... 499
 Wilhelm, Birgit 419
 Will, Silke 445
 Wiriya-Alongkorn, Winai
 . 481, 482, 491
 Wolff, Heinz-Peter . . 462,
 477
 Wollny, Clemens . . 62, 68
 Worbes, Martin 283
 Wu, Deng-Lin 418
 Wu, Lifeng 180
 Wulf, Sebastian 307
 Wullaert, Hans 273
 Wunder, Sven 346
 Wurzinger, Maria 52
- Y**
- Yamsakul, Panuwat ... 33
 Yan, Jiong 329
 Yongha Boh, Michael . 84
 Youan Bi, Athanase ... 76
 Yücel, Tülin 426
 Yusran, Yusran 514

Yusuf, Mohammed Hasan	487	Zeller, Heiko	115	Zöllmer, Christine ...	473
		Zeller, Manfred .	301, 336, 365	Zohari, Majid	142
Z		Zeray, Lijalem ..	358, 464	Zollitsch, Werner	52
Zabel, Astrid	333	Zeweil, Hassan	367	Zoss, Marc	148
Zahran, Eldur	524	Zhang, Yanjie	111	Zschiegner, Anne-Kathrin	329
Zander, Kerstin	73	Zhen, Lin	112	Zundel, Christine	417
		van der Zijpp, Akke ...	49		

Index of Keywords

A

- Abiotic stresses 449
- Absolute poverty 343
- Acacia 249
- Accounting'environment
..... 380
- Aceh 315, 386
- ACQUANET 294
- Acrocarpus fraxinifolius*
..... 284
- Adoption 61
 management 253
 models 188
 rate 179, 183
 role 182
- Aerial photo interpretation
..... 359
- Aerial photography .. 357
- Aerobic rice 484
- Afforestation ... 483, 490
- Afghanistan 446
- AFLP 223, 241
- Africa
 Eastern 423
- African
 breadfruit 442
 Catfish 34
 traditional vegetables
 217
- Agent-based modelling
..... 385
- Agrarian
 change 107
 systems 104
- Agri-environmental policy
..... 336, 342, 488
 systems ... 218, 347,
 402
- Agribusiness 133
- Agricultural
 biodiversity 435
 development ... 117,
 144
 economics 159
 innovation system ...
 194
 landscape 322
 marketing 139
 residues 306
 sector 360
 sustainability ... 167
 systems 354
 technology 182
 transformation pro-
 cesses
 359
- Agro
 diversity 227
 ecological zone .. 45
 pastoral system .. 51
- Agrobiodiversity
 . 206, 219, 222,
 228, 341, 402
- Agroecology 9, 259
- Agroecosystem 231
 service 327
- Agroenvironmental
 schemes .. 326
- Agroforestry
 . 221, 223, 238,
 255, 257, 323,
- Alfisol 457
- Allanblackia* 196
- Allergy to cow milk . 154
- Alley-cropping 488
- Allium* sp. 234
- Allometry 225
- Alternative
 land use 285
 protein source ... 34
- Amaranthus* 93, 242
- Amazon 252
 eastern 303
 western 311
- Amino acid 71
 requirements ... 37
- Anacardium occidentale*
..... 225
- Anden 206, 420
- Animal
 genetic resources . 73
 source foods 159
 tissues 367
- Ant plant 218
- Antagonists 522
- Antibacterial activity .. 33
- Antifungal activity .. 517,
 518
- Antioxidant capacity . 163
- Aquaculture 183, 188
- Aquifer system 475
- Arabian Peninsula ... 402
- Arabic ethnobotany .. 402

- Arbuscular mycorrhiza
 . 408, 439, 455
 fungi 514
 inoculation 516
- ArcHydro 361
- Area enclosure 274
- Argentina 112
- Arid areas 69
- Aromatic plants 233
- Artemisia annua* 489
- Ascorbic acid 166
- Assessment 185
- Astragalus* 338
- Atlantic
 forest 137, 317
 rainforest .. 208, 258
- Auctions 334
- B**
- BABA 515
- Bacillus* sp. 449
- Baking quality 171
- Balanced Nutrient Management Systems
 179
- Bali cows 22
- Bamboo 264, 304
- Banana 523
 leave 36
- Bangladesh . 56, 113, 120,
 475
- Baobab 238
- Barley 446, 476, 521
- Barnyard grass 36
- Baseflow separation . 358
- Baseline mapping ... 366
- BAX genes 74
- Beef quality 72
- Behavioural model .. 371
- Below-Ground BioDiversity
 401
- Benefit sharing 239
- Benin .. 45, 100, 122, 227,
 376, 405
- Betel vine 32, 33
- Bioavailability 153
- Biocontrol 508
- Biodiesel 303, 311
- Biodiversity 23, 175, 195,
 215, 231, 316,
 323, 326, 379
 conservation ... 218,
 233, 244, 314
 governance 232
- Bioeconomic model . 381
- Biofuel 301, 302, 308
 plantation 312
- Biogas 307
 plants 305
- Biological
 collections 195
 control 500, 525
 control agent ... 506
- Biopesticides 418
- Biophysical
 impact 386
 modeling 353
- Biosphere reserve ... 232
- Biotechnical conditions
 99
- Biotechnologies 155
- Biotopes 219
- Bivalves 321
- Black Sigatoka 508
- Black-boned chicken .. 71
- Blood indices 29
- Bolivia 23, 293
- Bootstrap 365
- Boron 445, 482
- Botanical
 characteristics ... 224
 insecticide 505
- Brachiaria ruziziensis* . 21
- Brazil . 51, 112, 137, 154,
 208, 258, 259,
 266, 272, 295,
- 303, 305, 311,
 317, 322, 347,
 456, 464
 northeastern 225
 Southeast 137
- Brazilian pine 272
- British Indian Ocean Terr.
 225
- Brix value 166
- Broiler 28–30
 feeding 27, 29
- Bt-cotton 180
- Burkina Faso ... 280, 379
- Burma (Myanmar) ... 53,
 204, 506
- C**
- C3P 523
- Cabbage 500, 506
- Calcareous soil . 410, 438
- Calliandra 17
- Cambodia . 134, 160, 244,
 260, 359, 486,
 497, 513
- Camel 55
- Cameroon 393, 454
- Canavalia ensiformis* . 34
- Candies 158
- Canola 406
- Capability approach . 172
- Capacity
 building 62
 development 194
- Carbon 368
 business 140
 estimation 356
 market 288
 sequestration ... 336
- Carcass composition .. 75
- Carnivore conservation
 333
- Carotenoids 275
- Carp 19
- Cash crop 388

- Cashew 225
- Cassava 30, 91
 peel 31, 92
 waste effluent ... 468
- Catalysis 311
- Catfish hybrids 53
- Cattle .. 21, 22, 54, 68, 76
 Boran 70
 disease 44
 exclosure 277
 farms 60
 N'Dama 70
 thrombitic meningoencephalitis .
 24
 Valdostana Castana .
 73
 White Lamphun . 75
- CBPP 44
- Cedrela*
odorata 284
- Cedrela* 283
- Ceratitits capitata* 502
- Certification 323, 424
- Chad 110
- Change detection 392
- Charcoal 304
- Chemical
 composition . 55, 224
 fertilizer 409
- Chicken 71
 performance 28
- Chickpea 506
- Children under 5 156
- Chile 324
- Chilling requirement . 216
- China 111, 112, 180, 270,
 316, 335, 390,
 424
 Southwest 152
- Chlorate 491
- Chlorophyll 275, 481, 485
- Choice experiment method
 324
- Citrus 470, 507
- Clean development mechanism
 59
- Climate
 change . 59, 140, 209,
 273, 301, 354,
 462
 gradient 216
 vulnerability 209
- Co-fermentation 307
- Co-operative associations
 140
- Co-substrates 307
- Cob production 454
- Cockerels 30
- Cocoa 107, 201, 221, 289,
 323, 403
 agroforestry 189
- Coconut 96
- Coffea arabica* 152
- Coffee 201, 264, 289
 certification 175
 forests 337
 organic 419, 421
- Cold sterility 448
- Collective
 action 137
 ownership 184
- Collector 85
- Colombia . 117, 129, 264,
 282, 292, 371
- Colour types 41
- Commercial compost 437
- Commercialisation .. 127,
 228
 index 249
- Common
 bean 438
 property resources ..
 134
- Communication 117, 208
- Communities ... 184, 337
- Community 135
- based
 management .. 68,
 340
 seed provision 194
 empowerment .. 435
 forestry 252, 253
 forestry instruction ..
 204
 satisfaction 281
- Compensation 346
- Competitiveness 105, 220
- Compliance 173
 costs 174
- Compost ... 84, 162, 405,
 516
- Conflict
 cycle 278
 management 340
- Conservation 234
 agreements 108
 tillage 118
- Consumer 89
- Contingent valuation .. 73
- Controlled fires 45
- Convention of biodiversity
 239
- Conventional
 protein sources .. 27
 territory 279
- Cooking
 fuel 96
 stove 82
- Correlation coefficient
 358
- Corynebacterium* spp. . 43
- Cost-benefit analysis . 265
- Costa Rica 375, 508
- Cottage industries 92
- Cotton 205, 222, 506
- Count model 498
- Covariate risk 113
- Cowpea 432
 breeding 187
- Credit constraints 143

- Critical success factors 130
- Crop
- livestock interactions 120
 - diversification .. 113
 - productivity 417
 - residue management 120
 - response 485
 - yield level 411
- Cropping
- calendars 448
 - sequence 487
- CropSyst 363
- Crude extracted betel vine 33
- Cultivars 425, 519
- Cultivated flora 402
- Cultivation 310
- Cultural
- factors 189
 - impact 271
 - values 73
- Cup quality 152
- Customary
- rules 278
 - tenure 278
- Czech Republic 165
- D**
- Daily gain 30
- Dairy farming ... 52, 378
- DD model 180
- DEA 60, 76, 364
- Decentralisation 334
- Decision
- making 204, 371, 389
 - models 375
 - support system . 112
- Decomposition 399
- Defoliator 221
- Deforestation ... 288, 295, 323, 393
- Degradation 317
- Demand-led
- approaches 182
 - service delivery . 194
- Denitrification 273
- Deoxynivalenol 522
- Derris elliptica* 35
- Desorption isotherms . 94
- Destination choice ... 329
- Developing countries 497
- Development
- policy 301
 - stage 446
 - synergy 244
- Devolution 108
- Diamondback moth .. 505
- Diffusion rate 183
- Digestibility 22
- Digital recording system 98
- Dimocarpus* 86
- Dioscorea* species ... 408
- Disease management .. 68
- Distillation 83
- Diversification 26
- strategies 261
- DNA isolation 367
- Dolichos biflorus* ... 443
- Domestic market ... 423
- Domestication .. 234, 237, 238
- Dressing percentage .. 75
- Drip 465
- irrigation 463
- Driving forces 183
- Drought 432, 504
- stress 453
 - tolerance 452
- Dry
- areas 58
 - meat 157
 - season feeding 57, 63
- Drying 85
- kinetics 87
- Dryland ... 186, 249, 356
- E**
- Earth summit 192
- Earthworms 412
- Easter Island 263
- Eating culture 150
- Ecofarming 203
- Ecological 45
- concepts 9
 - economics 259
 - forest compensation program .. 335
 - modeling 379
- Ecological Planning . 391
- Economic
- efficiency ... 60, 111
 - feasibility 51
 - growth 114
 - impact 512
 - incentives . 323, 336, 346
 - of biotechnology 154
 - performance 417
 - sectors 325
 - value 251
 - viability 305
- Ecosystem
- services ... 269, 315, 323, 343
- Ecotourism 134
- Ecuador 215, 220
- Egg production 20
- Egypt 37, 363
- El Niño ... 209, 374, 377
- Elicitation approach . 143
- Encroachment 467
- Endemic plants 220
- Energy 82
- Energy-balance 373
- Enriched stable isotope 38
- Enrichment plants 26

- ENSO 377
 Environmental
 degradation 258
 impact 205
 perception 322
 service payments 375
 services ... 246, 322,
 347
 Enzyme 307
 activities 410
 utilization 31
Eocanthecona furcellata
 506
 Equilibrium moisture con-
 tent
 94
 ERCGE Model 380
 Ergosterol 407
 Erratic rainfall 381
 ERSAM 380
Eryngium foetidum ... 88
 Essential oil .. 83, 88, 517
 Ethiopia 52, 68, 159, 171,
 175, 200, 261,
 274, 337, 358,
 421, 434, 474,
 487, 499, 509–
 512
 Ethnicity 189
 Ethnobotany 233, 238
 EU food safety standards
 174
Eucalyptus salmonophloia
 373
 Eugenol 518
 EurepGAP 172
 Evaluation 202
 tools 378
 Evaporative cooling ... 81
 Evapotranspiration effi-
 ciency
 432
 Exotic vegetables 217
- F**
 Faba bean . 440, 441, 487
 Facilitation 341
 Faecal
 colour 32
 indicators 84
 marker 42
 score 32
 Fair Trade 175
 Fallow 122, 221
 improved 434
 land 262
 Fallow 405
 Farm
 family income .. 387
 scale 172
 size 172
 Farmer
 capacity building 117
 contest 202
 education 422
 field school 180
 groups 182
 seed systems ... 435
 training 418, 523
 Farming
 practices 401
 systems 67, 202, 261,
 322, 364, 462
 lowland 58
 mountain 58
 vegetables ... 105
 Farmyard manure ... 434,
 438
 Fatty acid 71
 Feed
 conversion ratio .. 32
 intake 20, 22, 42
 protein demand .. 39
 Feeding patterns 156
 Fern 226
 Fertiliser
 application 457
 inorganic 179
 rate 487
- Fertility 41
 management 405
 Fibre 19
 Film-coated polymer . 517
 Fire wood 309
 Fish farming 183
 Fishmeal 34, 39
 Flash floods 361
 Flesh colour 87
 Flood 113
 Floodwater harvesting 361
 Flower induction 491
 Fodder 50
 Foliar
 application 482
 fertilisation 445
 Food 50
 aid 200
 chain 40
 crops 122
 deficit 135
 equipment design ...
 100
 insecurity 362
 processing 100
 production .. 60, 464
 safety 89, 441
 safety standards . 172
 security
 119, 121, 167–
 169, 171, 243,
 246, 403
 supply 168
 Forage
 conservation 61
 legume 50, 222
 Forages 54
 Forest
 co-management . 265
 conservation ... 322,
 324
 conversion 107
 degraded 235
 ecosystem 325

- garden 218
 grazing 23
 inventory 250
 land use 278
 management ... 279,
 314
 approaches ... 281
 planning 282
 policy 278
 regeneration ... 235
 resources 256
 structure 255
 tree regeneration 262
 tropical lowland 273
 use 271
 user group 204
 vulnerability ... 260
 Fresh-fruits 95
 Fruit
 drying 87
 flavor 90
 wild species ... 245
 Fuel
 properties 309
 wood 274
 Functional biodiversity
 347
 Functioning 172
 Fungal
 community 407
 diseases 525
 Fungicide . 517, 522, 525
Fusarium
 oxysporum 525
Fusarium 524
 head blight 522
G
 Galapagos islands ... 220
 Gaseous emissions .. 368
 Gender 62, 184
 Gene-phene-scene-contin-
 uum
 354
 Genetic
 diversity ... 223, 241
 erosion 243
 fingerprinting ... 238
 polymorphism .. 443
 resources 272
 variation 515
 Genotypic
 correlation . 440, 453
 variance ... 440, 453
 German development coop-
 eration
 192
 Germany ... 20, 444, 514
 Germination 308, 442
 Germplasm 152
 Ghana . 84, 133, 285, 461
 Gini Coeficient 114
 GIS .. 220, 279, 361, 379,
 387, 391, 472,
 507
 Global
 changes 67
 drivers 49
 environmental gover-
 nance
 134
 network 341
 review 130
 warming 59
Glomus mosseae ... 516
 Glucosinolates 41
 Goats 42, 69
 cheese 154
 manure 404
 Good agricultural practices
 193
 Governance 467
 GPS 279
 Grass carp 36
 Grassroots
 breeding 435
 institutions 435
 Grazing 42, 277
 type 72
 Green revolution 219
 Greenhouse 81
 gases 59
Grewia tenax 483
 Greywater 461
 Groundwater ... 109, 463,
 466
 Group Certification .. 422
 Growing stock 250
 Growth
 analysis 456
 rates 284
Guadua angustifolia . 264
 Gum 249, 362
Gum olibanum 236
H
 Haematology 28, 34
Haemophilus somnus . 24
 Harvest
 efficiency 93
 mechanisation ... 93
 technique 99
 Harvester 93
 Head loss 464
 Health
 effects 170
 problems 513
 Heat
 stress .. 20, 433, 440
 treatment .. 176, 520,
 521
 Heavy
 metals 136, 161, 162,
 226
 Hedgerow systems .. 400
Helicoverpa armigera 506
Heliocheilus albipunctella
 504
 Herbs 83
 Heritability . 70, 408, 453
Hermetia illucens 39
Hernia inguinalis 74

- Heterobranchus longifilis* 34
- Heterogeneity 373
- High altitude cropping 448
- High value agriculture 149
- Higher education 144
- Histophilus somni* 24
- Homegardens .. 234, 243, 245
- Honduras 54, 61, 173
- Horizontal nutrient fluxes 436
- Horse gram 443
- Horticulture 500
- Housefly maggot meal 19, 38
- Household
demand 186
food security ... 127
model 57, 302
supply 466
survey 106
- Human
development index .. 114
ecosystem 278
health 499
- Hydraulic 464
- Hydroponics ... 451, 526
- Hydrostratigraphic model 475
- Hydroxyl 163
- I**
- Ice cream 291
- Ideal protein concepts . 37
- Idiosyncratic risk 113
- Image of nature 329
- Imitation milk 158
- Impact assessment .. 187, 205
- Impervious surface .. 390
- Implementation 121
- Improved fallow 434
- In situ* conservation .. 245, 293
- In-situ* conservation .. 314
- Incentives 257
- Income 152
and employment 170
generation . 196, 246, 285
improvement ... 121
inequality 114
portfolio 115
- India .. 99, 109, 120, 153, 167, 233, 239, 321, 339, 381, 443, 452, 463, 467, 519
- southern 321
- Indigenous
breed 77
fallow management . 353
fruit trees 483
knowledge .. 68, 233
- Indonesia .. 104, 105, 107, 108, 135, 150, 302, 315, 323, 336, 340, 343, 374, 377, 386, 388, 389, 471
- Infants 159
- Infiltration coefficient 390
- Informal employment 103
- Inhibiting forces 183
- Innovation .. 61, 129, 253
- Insect
damage 454, 507
pest 504
proteins 39
- Insecticidal effect ... 510
- INSL3 74
- Institutional arrangement 312
- Integrated
control 525
evaluation 288
fertilisation system .. 406
production 40
regional model . 376
- Integration 472
- Intellectual property rights 239
- Intensive smallholder dairy farms 50
- Interdisciplinary modelling 374
- International
CO₂-markets ... 342
potato center ... 420
research 187
- Intrinsic transpiration efficiency 432
- Invasive 507
plants 220
weeds 512
- IoS frame work 339
- IPM 205, 498
- Iran .. 136, 142, 222, 234, 237, 254, 255, 279, 338, 391, 392, 406, 409, 422, 437, 490
- Iron
toxic soils 451
toxicity tolerance ... 449
uptake 449, 450
- Irradiance 488
- Irrigation .. 136, 242, 447, 464, 465, 470, 474–476, 490
farming 51
- Isotope ¹⁵N 38
- Italy 73
- Ivory Coast (Cote D'Ivoire)

- 22, 76
 IWMI 461
- J**
- Jackbean 34
Jatropha curcas .. 99, 308
 Jordan Valley 462
 Juice extraction 95
- K**
- Kazakhstan 356
 Kenya .. 44, 69, 172, 182,
 187, 203, 219,
 228, 251, 271,
 281, 342, 401,
 500, 522
 Khartoum city 366
Khaya senegalensis .. 284
 Kidney beans 27
- L**
- Lac sticks 56
 LAI 356, 456, 485
 -SEB Model 280
 Land
 and water manage-
 ment
 376
 cover 390
 changes 359
 degradation 312
 evaluation 469
 intensification .. 401
 rights 111
 use change 266
 Land use .. 302, 389, 412
 alternative 285
 change 122, 346, 375,
 386, 393, 395
 changes 112
 diversification strat-
 egy
 135
 management ... 208,
 258, 403
 map 392
 modelling . 385, 388,
 391
 perceived benefits ...
 261
 strategies 394
 systems 410
 Landsat ... 355, 357, 390
 Landscape
 ecology 259
 history 317
 model 394
 Landslide 338
 Laos 132, 207, 304
 Late blight 515
 Latin America 23
 Lead contamination .. 157
 Leaf
 area index 456
 symptoms 450
Lecanicillium muscarium
 502
 Lectin 443
 Legumes 17, 405
 Leguminous 456
Lepidium meyenii 41
 Linear programming
 . 336, 363, 374,
 464, 477
 Litchi 309, 445, 481
 Litter decomposition . 412
 Litterfall 276
 Livelihood 236, 245, 263,
 378
 improved 342
 perspective 201
 strategies 207
 Livestock 52, 58, 62, 131,
 222, 333
 keepers' knowledge .
 69
 modernisation ... 59
 production 26, 63, 67
 Local
 action groups ... 334
 breeds 69
 communities ... 195
 crop development ...
 435
 indicators 348
 knowledge 209, 256,
 261, 304
 organisational devel-
 opment
 194
 resource management
 108
 Locust meal 28
 Loess Plateau 327
 Long drought 135
 Long-term experiments
 417
 Longan .. 86, 87, 90, 309,
 482, 491
 Low input system ... 444,
 514
 Lower Amazon basin 263
- M**
- Macro
 economic policy 360
 minerals 25
 Maize 231, 434, 456, 457,
 503
 cultivars ... 453, 455
 grain yield 454
 performance 119
 stover mulch ... 399
 Malaria 489
 Malawi 143, 183, 265
 Malnutrition 156
 Management skills .. 418
 Mango 95, 166, 309
 Mangrove 385
 ecosystem 339
Mansonina altissima .. 223

- Manure 406
 application 179
 Mapping 220
 Market
 chain analysis .. 238
 distortions 362
 gardens 436
 participation 131
 Marketing arrangements
 77
 Marshlands 121
 Mass spectrometry 90
 Mathematical models 395
 Meat quality 157
 Mechanisation . 91, 97, 99
 Medicinal plants 233
 Mediterranean fruit fly
 502
Melia azedarach 353
Melissa officinalis 94
 Methane 59, 307
 Mexico 25, 231, 275, 276,
 284, 410, 412
 northeastern 275, 276
 Micro
 climate 81, 488
 minerals 25
 nutrients 481
 penetration .. 445
 translocation . 445
 satellites 367
 Microbial biomass .. 404,
 411
 Midwives 215
 Migration . 104, 189, 206
 Milk production .. 17, 54,
 57
 Milled rice 176, 520
 Millenium development
 goals 301
 Millennium development
 goals 130, 133,
 142, 182
 Millet worm 504
 MIMIC 172
 Mineral N 413
 Mitigation 315
 Modelling . 269, 354, 358,
 373, 378, 389,
 448, 462, 473
 MODIS 355
 Moisture content 85
 Moldova, Republic .. 144
 Molecular markers .. 154
 Morels Disease 43
 Mortality 502
 Mozambique 184
 MSW compost 161
Mucuna 434
 Mulch 399, 454
 Multi
 chain approach . 201
 cropping systems ...
 402
 locational trials . 408
 market 169
 nomial logit 103
 stakeholder process .
 132
 strata production sys-
 tems
 257
 Multiple-use forest manage-
 ment
 316
 Multivariate
 analysis ... 264, 347
 regression 280
 Municipal effluent ... 136
 Musa (AAA) 508
 Muskmelon 447
 Myanmar 506
 Mycoherbicide . 524, 525
 Mycorrhiza 413
 Mycorrhizal management
 514
 N cycling 273
 N'Djaména 110
 Nagaland 167
 NAM model 361
 Napier grass 36
 Nash-Sutcliffe simulation
 efficiency . 358
 National park .. 189, 226,
 323
 management 108
 Native
 cattle 75
 Mexican grasses . 25
 oil crops 303
 pasture 22
 trees and shrubs . 275
 Natural
 control 507
 pest-control 218
 pesticides 513
 resource degradation
 328
 resource management
 137, 184, 187,
 340
 ventilation 81
 Nature conservation .. 40
 NDVI 355, 356, 377
 Neglected crops 218
 Nematode management
 508
 Neoliberalism 134
 Nepal .. 62, 243, 250, 253,
 387, 435
 Net income 53
 Net present value 372
 New York MarketMaker
 139
 Nicaragua 58, 498
 Niger .. 89, 157, 368, 436
 Nigeria 26, 29–31,
 85, 97, 115, 155,
 168, 179, 185,
 196, 221, 223,

N

- 235, 306, 408,
 442, 455, 457,
 465, 468, 470
- Nile
 perch 174
 tilapia 53
- Nitrate 437
- Nitrification 273
- Nitrogen 368, 476
 content 452
 fertiliser 444
 leaching 400
 mineralization .. 400
- Non timber
 forest products . 132,
 196, 236, 251,
 254, 316, 424
 forest products
 (NTFP) ... 372
 forestry 253
- Non-competitive tree inte-
 gration
 261
- Non-feed additives .. 160
- Non-material benefits 246
- North-south relation . 134
- NP fertilisers 434
- NTFP 196, 218, 236, 251,
 254, 316, 424
- Nutrient
 elements 490
 fluxes 372
 utilization 31
- Nutrition ... 19, 159, 246
- Nutritional
 anaemia 156
 quality 425
 status 482
 value 151, 158
- Nutritive value 21
- NWFP assessment ... 250
- O**
- Oasis 216
- Occupational choices 103
- Ogi 151
- Oil
 cracking reactor 311
 crops 96, 303
 production
 small-scale 96
 rapeseed 406
 seed 97, 444
 crops 310
- Okra 151
- Oman .. 42, 216, 402, 439
- On-farm trees 223
- Onion dried 89
- Open access 343
- Opportunity costs ... 295
- Optimization 363
 model 375
- Ordered probit 281
- Oreochromis niloticus* . 38
- Organic
 agriculture . 127, 258,
 417
 certification 422
 coffee 419
 farming ... 142, 218,
 414, 426
 fertiliser ... 447, 486,
 508
 manure 409
 market 418, 419
 matter 438
 potato production ...
 420
 tea 419
 tomato 425
 vegetables 423
- Organomineral fertilizer
 439, 455
- Orinoco 195
- Oryza sativa* 450, 451
- Out-of-sample test ... 365
- Over-fishing 321
- Oxidation power 450
- P**
- P fractionation 404
- Pakistan 103, 411
 Northwest 103
- Palm oil 302
- Panama 273
- Pangola grass 18
- Parachanna obscura* .. 35
- Parasites 84
- Parasitic
 wasp 503
 weeds 524
- Parthenin 499, 510
- Parthenium hysterophorus*
 . 499, 509–512
- Participation 206, 208
- Participatory
 development ap-
 proaches
 194
 plant breeding .. 435
 supply chain analysis
 132
- Passion fruit 166
- Pasture crop integration
 51
- Payment for environmental
 services .. 335,
 336
- Payments for environmen-
 tal services
 346
- PCRaster 473
- Pennisetum*
 purpureum 21
 typhoides 504
- Pepino mosaic virus . 526
- Pepper 161, 162
- Per caput area 167
- Perception 271
- Performance
 characteristics ... 27
 payments 333
- Peri-urban agriculture . 52,

- 110, 366
 Peroxyl 164
 Peroxynitrite 164
 Peru . 41, 57, 88, 206, 209,
 257, 290, 294,
 310, 355, 420
 Peruvian Amazon 88
 Pesticide .. 153, 371, 500
 chemical 513
 health effects ... 498
 natural 513
 Pests 501
Phaseolus vulgaris .. 438
Phaseolus vulgaris ... 27
 Phenolic
 acid 165, 510
 content 241
 Phenotypic variation . 237
 Philippines . 96, 188, 308,
 348, 484, 501
 Phosphorus 413
 application 438
 Photooxidative stress 445
 Photosynthesis 481
 Phyllody 511
 Physicochemical
 properties .. 151, 158
 Phytoecological zone 379
 Phytoplasma ... 509, 511
 Phytosanitary ... 520, 521
 Pigs 30, 74, 77
 diet 32
 performance 31
 production 305
 Pineapple ... 95, 166, 291
Pinus
 eldarica 136
Pinus
 culminicola 277
Pinus
 eldarica 490
 Pipe diameters 464
Piriformospora indica
 526
- Pit latrine 84
 Plant
 architecture 373
 extract 505
 genetic
 diversity 433
 genetic resources 243
 oil 82, 96
 species selection . 23
 strengtheners ... 515
 water relations .. 373
 Plantation
 conversion 316
 forestry 270
 Planted forest 272
Plukenetia volubilis .. 310
 Policy 141
 adaptation 326
 Analysis Matrix
 (PAM) 362
 decision support sys-
 tem
 112
 impact 378
 intervention ... 362
 simulation 380
 transfer 326
 Pollution potentials .. 468
 Polymerase chain reaction
 367
 Pomegranate 216
 Population
 dynamics 501
 growth 167
 parameters 70
 structure 274
 Post harvest loss .. 89, 91,
 497, 503
 Potassium chloride ... 20
 Poultry 367
 Poverty 67
 alleviation . 189, 285,
 312, 333
 assessment 365
- assistance 143
 reduction .. 187, 193,
 207
 Power dependence ... 173
 PPP 196
 PRA tools 328
 Prawn 321
 Precipitation 411
 Predators 501
 Predatory bug 506
 Preservative methods 224
 Primary forest 235
 Prior Informed Consent
 239
 Pro-poor growth 133, 170,
 192
 Probiotic 32
 Processing technology
 153, 168
 Product
 differentiation .. 129
 quality 87
 Production
 cost 306
 Productivity 205
 enhancement technol-
 ogy
 381
 Propagation 308
 Property rights 204
 Protein 165
 assimilation 38
 digestion 38
 Proximate composition 35,
 442
 Proxy means test 365
 Pseudomonades 514
 Public-private-partnership
 289
 Puding area 390
- Q**
 Quality
 control 150

- of life 258
- R**
- Rabbits 30
- Radio frequency 176, 520, 521
- Rangelands 338
- Rattan extraction 343
- Raw lac 56
- Recycled water 477
- Reduced tillage 399
- Reforestation ... 208, 258
- Regeneration 314
- Regional model 477
- Rehabilitation 277
- Relative advantage .. 183
- Remote sensing
280, 315, 355–357, 359, 361, 377, 379, 387, 390, 393, 472
- Renewable energy 86, 304, 306, 309
- Reproductive
performance 69
stage 453
- Research
and development . 62
extension farmer link-ages 182
platform 341
- Residue quality 407
- Resilience 260
- Resin
-P 404
core method 400
- Resistance
induction 515
mechanisms 451
- Resource
base 250
conservation 337
- conserving technolo-gies 120
- depletion 467
- efficiency .. 105, 417
- poor systems 69
- proficiency 263
- protection 433
- value 380
- Restoration 277
- Rice 501
fish culture 53
lowland 449
paddy 485
production 486
seed borne fungi 518
treatment 176
upland 115, 450, 452
wheat-system ... 448
- Risk
management 374
perception and re-sponse 261
- Rockware 2004 475
- Root
knot nematode .. 484
length 413
- Rotation 179
- Roxazyme -G 29
- Rubber 266, 292
- Rumen
environment 22
microbial proteins 18
- Runoff 98, 473
- Rural
area 140, 156
community 256
enterprises ... 130
development ... 132, 133, 252, 472
economy 104
employment 141
forest interface . 260
- households 251
vulnerability . 113
- labour markets .. 107
- livelihood analysis .. 115
- sector in Africa . 141
- sociology 104
- Rwanda 121
- S**
- Saccharides 165
- Sacha
culantro 88
inchi 310
- Sacred forest 271
- Safflower 444
- Sahel 413
- Salinisation 471
- Salinity 469, 483
- Salmonella* spp. 33
- Salt resistance 446
- SAM 360
- Sanitary 150
- Scale efficiency 116
- Scaling up 193
- Scenario analysis 302, 394
- School project 203
- Seasonal
effect 410
influence 55
- Secondary compounds 41
- Seed 26
borne fungi 521
coating 525
coating technology .. 518
density 444
germination 483
- Seedling 277
- Sefidrood basin 391
- Selection criteria 453
- Semi-arid land 379
- Sensitivity analysis .. 358

- Sensory 388
 evaluation . 151, 158
- Settlement schemes .. 119
- Shea
 butter 97
 fruit 97
- Sheep abscess 43
- Shifting cultivation .. 167,
 262
- Silage 21, 61
- Silvopastoral systems . 23
- Simulation 373
 model 294
 software 86
- Site quality 282
- Sitophilus oryzae* 520
- Sloping Land Conversion
 Program .. 335
- Small food vendors .. 150
- Small-scale
 farmers' preferences
 257
- Smallholder .. 49, 58, 149,
 219, 342, 418,
 419
 agriculture 259
 forest plantation de-
 velopment
 285
- SMC compost 162
- Social
 capital 200
 learning 132
 stratification 189
- Socio-ecological
 analysis 421
 dilemma 343
- Socio-economic 45
 analysis 366
 characteristics .. 257
 impact 129
 situation 472
- Socio-environmental sys-
 tems 388
- Sodicity 469
- Soil
 and Water Analysis
 Tool 358
 chemical properties .
 412
 classification ... 469
 conservation 185
 cover 284
 erosion 290
 fertility 227, 405, 408,
 417, 439, 455
 fertility management
 420
 health 399, 484
 management 202
 moisture ... 452, 465
 nitrogen 26
 organic C .. 403, 411
 organic matter man-
 agement
 401
 pollution 136
 quality 474
 supplementation 516
- Solanum lycopersicum*
 433
- Solar 85
 collectors 83
 design 86
 drying 88, 89
- Sooty mold 507
- Sorghum bicolor* 224, 525
- South Africa ... 131, 194,
 404
- Sowing method 476
- Soy sauce 160
- Soybean 179, 445
- Spatial
 differentiation .. 387
 modelling 387
 variability 485
- Specialty coffee 129
- Species
 diversity 235
 evenness 235
 recovery 272
- Spectral transformation
 392
- Spiders 501
- SPOT Vegetation 355
- Sprinkler 465
- Sri Lanka 385
- SRTM 355
- SSWATmodel 290
- Stable carbon isotopes
 283
- Stakeholder
 analysis 137
 participation 467
- Staphylococcus aureus* 43
- Steers 18
- Stem mass density ... 432
- Storage
 facilities 168
 methods 442
- Strategy
 revitalizing agricul-
 ture
 228
- Street foods 150
- Striga hermonthica* .. 524
- Striga hermonthica* .. 525
- Students 206
- Subsidy 169
- Subsistence 278
 crop 388
 farmer 118
- Success and Failure Factors
 232
- Sudan 24, 43, 55, 156,
 169, 186, 227,
 236, 249, 256,
 357, 361, 362,
 366, 438, 440,
 441, 447, 453,
 476, 478, 483,

- 488, 504, 524
soils of 469
Sudanian zone 405
Sulawesi 388
Supplementation 17
Supply chain ... 149, 201, 497
Surangin B 505
Surface
 flow 358
 water 98, 468
Sustainability .. 204, 222, 339
 impact assessment .. 112
 indicators 348
Sustainable
 agriculture 193
 approach 91
 development 49, 192, 259, 391
 extension 254
 indicators 394
 land use 40, 245
 livelihood . 187, 285, 342
 rural livelihood . 244, 348
 tourism 329
 utilization of timber . 270
Sustainable agriculture 117
Swidden agriculture . 353, 473
Swietenia humilis 284
Swine manure 305
Syria 364, 502, 526
System
 analysis 354
 comparison 417
 rice intensification .. 486
Taiwan 418
Taiwan dryer 87
Tamarillo 164
Tamarind 238
Tamaulipan thornscrub 276
Tannins 17
Tanzania .. 149, 174, 217, 500
Tapping 236
Tarak-tarak 236
Taungya 223
Tea
 organic 419
Technical efficiency . 116
Technology
 adoption 185
Tectona grandis 284
Tef 171
Temporal dynamics . 386, 471
Terminalia 283
Terraces 206
Territorial organization 279
Thai native cattle 72
Thailand 32, 60, 71, 72, 74, 75, 81, 86, 87, 106, 176, 224, 226, 242, 245, 309, 400, 414, 433, 472, 481, 482, 491, 505, 518, 520, 521
Theatre 206
Tilapia ... 19, 37, 38, 188
Tillage 457
 system 487
Timber market 270
Time analysis 355
Titratable acids 166
Tobacco cultivation .. 208, 258
 regression 60, 76
Togo 445
Toilet 84
Tomato 81, 409, 418, 433, 516
 cultivars 439
 dried 89
Trade-off analysis ... 201
Traditional
 attitudes 271
 forest management .. 255
 healing practices 215
 knowledge . 215, 239
Transition economy . 116
Transmission 509
Treculia africana 442
Tree
 crops 315, 386
 damage 471
 density 280
 diversity 405
 rings 283
 species 221
 uses 256
Triplochiton scleroxylon 223
Triticale 171
TRNSYS 86
Tropical
 agriculture 388
 fruits species ... 245
 grass 18, 63
 mountainous regions 400
 rainforest .. 235, 260, 388
Trypanotolerance 70
Tsetse fly 68
Tsunami .. 315, 385, 386, 389, 471
Turkey 395, 426

T

Tobit

U

- Uganda . 50, 59, 127, 202, 365
- Ultisol 454
- Under-privileged communities 233
- Underutilised species 246, 372
- United States 139
- Units of forest management 282
- Upgrading 173
- Upstream 497
- Urban agriculture 52, 110, 366, 368, 436
- Uruguay 112
- Uzbekistan 116, 376
- V**
- Valuation 327
- Value
 adding 170
 chain . 129, 133, 149, 201, 289, 292, 424
 integration ... 130
- VAM 519
- Variety 418
- Vegetable . 149, 418, 437, 497
 consumption ... 170, 217
 diversity 217
 production . 110, 170
- Vegetation
 change 355
 classification ... 379
 cover 473
 response 377
- Vegetative stage 453
- Venezuela . 291, 372, 407
- Vertisol 407, 447
- Viet Nam 36, 77, 106, 262, 278, 353, 451, 473, 485, 497
 northern 353
- Vigna unguiculata* 17, 432
- Volatile compounds ... 90
- Volta river basin 379, 466
- Vulnerability ... 325, 385
 to poverty 106
- W**
- Wadis 361
- Wallis & Futuna Islands 327
- WaNuLCAS 353
- Wastewater 490
- Water
 activity 94
 intake 20
 management ... 202
 quantities 478
 scarcity ... 467, 489
 security 466
 stress 470
 use 461, 472
 efficiency 40
- Water-saving rice production 484
- Watershed . 109, 361, 390
 development programme
- 381
 protection 335
- Weaning pig diet 32
- Well 468
- Wetlands 121, 355
 use values 321
- Wheat 222, 487, 519, 522
- Wild
 fruit trees 237
 species 215
- Willingness to pay ... 324
- Wood production 270
- Woodland 265, 276
- Woolly whitefly 507
- X**
- Xanthomonas wilt* ... 523
- Y**
- Yacon 165, 241
- Yam 85, 408
- Yield 465
 components ... 242, 432, 446
 improvement ... 437, 441
 per unit water ... 478
 stability 440
- Z**
- Zea mays* 453, 456
- Zero grazing 52
- Zimbabwe . 118, 119, 399
- Zinc 445, 482
- Ziziphus spina-christi* 483

