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Telefon: 0228 734001
Telefax: 0228 732489
email: aci@uni-bonn.de
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Preface

Globalization and rapid advances in research appear to benefit in initial steps the developed world. In much of the tropics and subtropics, the potential gains of the “One World” seem to do little to improve the quality of life. An unequal distribution of resources enhances rural poverty and feeds urbanization. In the rapidly growing cities, over-population and competition for land and water provokes conflicts and increases pollution of the environment with implications for food quality and human health. On the other hand, low input agricultural production in the under-privileged rural areas is frequently associated with an over-exploitation of the natural resource base and the destruction of forests, soil, water reserves and biodiversity.

Beyond its general objective of enhancing food security for feeding increasing populations, agricultural research must increasingly contribute to improve the quality of life in the tropics. Inter-disciplinary approaches are needed that allow rural populations to sustain income and agricultural production in harmony with nature while providing sufficient quality food, clean water and a healthy environment to cities. To be successful, such research must involve ecologists, sociologists, geographers, medical doctors, and environmental scientists in addition to scientist representing the “classical” agronomical disciplines.

The annual Conference on International Agricultural Research for Development “Deutscher Tropentag” hosted this year at the University of Bonn, aims to contribute to bridging the gap between research and technology transfer and at the same time to stimulate dialogue and multi-disciplinary, integrative, and international collaboration.

Prof. Dr. Mathias Becker
Plantnutrition in the Tropics and Subtropics
University of Bonn

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Introductory Key Note

You Can't Eat GNP: Economics as if Ecology Mattered

Davidson, E.A.

*The Woods Hole Research Center, P.O. Box 296, Woods Hole, MA
02543, USA.*

Soil is one of the essential natural resources upon which our economic livelihood is based, but this role of soil is mostly unrecognized in the marketplace. Soils, like many other natural resources, usually are either under-priced or given no monetary value at all. Indices of economic prosperity, such as gross national product (GNP), do not include the value of soil improvement or degradation. Soils are often mined of their agricultural potential for short-term profits that contribute to the short-term GNP growth, but our long-term food supply and long-term growth of GNP will require wise management of soils. Improvements in agricultural technology have allowed us to produce more on the same amount of land, and, in some cases, with less and less topsoil. However, soil will always remain an essential resource, because, unlike some resources, soil is not completely substitutable. These generalizations apply to both the developed and developing worlds, but the issue of valuing soils is particularly challenging in developing nations. Development projects designed to open up new frontiers for the landless poor, such as the "Avança Brasil" project of the Brazilian government, tend to depress land prices, thus discouraging investments in soil conservation and other practices that would improve agricultural sustainability. Hence, attempts to provide cheap land to smallholder farmers may be counter-productive by creating disincentives for investments that are needed for long-term prosperity and alleviation of poverty. Our challenge as scientists is not only to help design sustainable agricultural management tools, but also to make the public aware of the crucial role that soils and other natural resources play in the economic prosperity of our society. Neoclassical economics, which has enormous influence on policy decisions, erroneously assumes that all resources are substitutable. To the contrary, I believe that experience in the natural sciences demonstrates that soils, clean water, forests, and a habitable climate are basic natural resources that cannot be completely substituted in an economically and ecologically viable world. Both healthy economies and healthy environments require recognition of the monetary and non-monetary values of these resources.

Symposium I

Production Systems Management

I.1 Successes, growth rates and experiences with direct seeding in Latin America.

Derpsch, R.

No-tillage Consultant, CC13223 Shopping del Sol, Asunción, Paraguay, (formerly GTZ, German Agency for Technical Cooperation). (rderpsch@highway.com.py)

Paradigms of agricultural production have changed drastically in the last three decades. Maximising yield per unit area has given way to maximising economic returns. Soil resource exploitation has given way to rational site-oriented use of the soil. Unsustainable ways of agricultural production are no longer accepted and have given way to sustainable land use. It has been recognised that only if sustainable production on the farm site is accomplished, sustainable rural development can be achieved. Finally it is being recognised that sustainable rural development is a prerequisite for global sustainable development. Despite this progress, still the majority of farmers and scientists around the world feel that soil tillage is necessary to produce a crop, that plant residues have to be buried with tillage implements, that bare soil is a normal consequence of tilling the soil and that soil erosion is an unavoidable process associated to modern farming. In Latin America these paradigms are rapidly changing. With farmers not tilling the soil for up to 30 years, farmers and researchers have come to the conclusion that a) tillage is not necessary to produce a crop, b) plant residues have to remain on the soil surface as mulch and not be buried, c) in the tropics the soil must be permanently covered with crop residues, and d) soil erosion is merely a symptom that for that area and ecosystem, unsuited methods of farming are being used. These changes of paradigms have brought about drastic changes in the methods of farming. In Brazil for instance no-tillage adoption increased from one million ha in 1990 to 15 million ha in the year 2001. In the same period no-tillage adoption in Argentina increased from 300.000 ha to 11.7 million ha and in Paraguay it increased from about 10.000 ha to more than 1 million ha. Although worldwide the biggest area under no-tillage is found in the USA, in this country the technology is applied only on 17,5% of the total cultivated area, against 39% in Brazil, 46% in Argentina and 55% in Paraguay. In relation to the total cultivated area, Paraguay is among the countries with the highest adoption rate of no-tillage in the world.

I.2 Citrus production in the savannah of western Nigeria: current status and opporunities for research input

Aiyelaagbe, I.O.O.¹, Afolayan, S.O.², Odeleye, O.O.², Ogunbayigbe, L.O.², Olufolaji, A.O.²

1. *Research and Development Centre, University of Agriculture, P.M.B.2240 Abeokuta, Nigeria.* 2. *National Horticultural Research Institute, P.M.B.5432 Ibadan, Nigeria.*

A diagnostic survey of citrus production was conducted in the savannah zone of western Nigeria (Oyo North). The aim was to assess the current status of citriculture, the impact of improved production technologies generated by two decades of research and to identify in collaboration with farmers, major production constraints which could be redressed by available technologies. The citrus trees were 11-35 years old and generally in a state of declining productivity. Most farmers (73%) intercropped their citrus trees with at least two of the following crops: cassava, yam, plantain, maize, pepper, plantain, cocoa and mango. The proportion of farmers who had adopted the recommended production technologies were 11% (use of budded seedlings of improved citrus varieties), 14% (fertilizer application) and 20% (7m x7m spacing). Under the farmers' cropping system, most of the orchards (58%) yielded < 10 t ha⁻¹ worth < N5000 (240DM) ha⁻¹. 96% of the farmers planned to expand citrus production the following year. The most preferred species were sweet orange (*Citrus sinensis*) and tangelo (*C. reticulata* x *C. pardisi*). Major production constraints listed by farmers were high pest and disease infestation and dearth of budded seedlings of improved citrus varieties. Although this was not mentioned by farmers, it was observed that some of the crops combined with the citrus trees were likely detrimental to optimum fruit production. Based on farmers' plans, preferences and production constraints, the major interventions suggested for increased productivity of citrus in Oyo North are the training of the local Agricultural Extension agents in integrated pest management of citrus, the establishment of decentralized citrus nurseries to produce mainly sweet orange and tangelo budlings and the introduction of intercrops which are acceptable to the farmers but not detrimental to the performance of the citrus trees.

I.3 Integrated energy farms: The FAO-UN project towards sustainable food and energy management

El Bassam, N.

Federal Research Center for Agriculture, Bundesallee 50, D-38116 Braunschweig, Germany.

Energy question, which has been paid little attention in food programs in the past, is of crucial importance, since it offers the chance to solve other, subordinate problems at the same time: It can improve the availability and distribution of water considerably and boost the food production. The concept of the Integrated Energy Farm (IEF) considers the optimization of the energetic and food autonomy and based on ecologically semi-closed system. The IEF integrate the growing of food crops, fruit trees, annual and perennial energy crops and short rotation forest along with fish and animal husbandry. Energy production based mainly on combined renewable energy sources biomass, solar and wind. It will promote rural development and improve the socio-economic and education chances. The contribution will describe the results of the complete study for the implementation of such farms in different regions of the world and the project under realization in Germany.

I.4 Managing seasonal soil N-dynamics in rice-wheat cropping systems of Nepal

Pande, K. R., Becker, M.

*Agrikulturchemisches Institut, Universität Bonn, Karlrobert Kreiten
Str. 13, 53115 Bonn, Germany. keshabrajpande@hotmail.com*

The rice-wheat annual double cropping system provides food for an estimated 400 million people in South Asia and occupies some 0.5 million ha in the Himalayan foothills of Nepal. A crop of wheat, grown during the dry season under upland conditions, is followed by a crop of flooded rice during the wet season. Mineral N fertilizer use in the predominant small-holder agriculture is low and crops rely largely on native soil N for their nutrition. Alternating soil drying and wetting cycles stimulate N losses. This is likely to be most severe during the 3-month dry-to-wet season transition period after the harvest of wheat and before the transplanting of rice. Managing native soil N is essential to sustain productivity of rice-wheat rotation systems. Soil N dynamics and transformation processes were determined in seasonally flooded soils under controlled conditions in a greenhouse. A gradual increase in soil moisture content (simulated dry-to-wet season transition period) resulted in a nitrate peak of 25 mg N kg⁻¹ of bare potted soil at 40% water-filled pore space. A rapid decline of nitrate at higher soil moisture levels was associated with a peak in N₂O emissions (denitrification losses). Incorporation of wheat straw and/or nitrate immobilization by growing green manure crops (*Zea mays*, *Mucuna pruriens* var. *utilis*, *Vigna radiata*) reduced N losses and resulted in soil nitrate peaks of only 1-5 mg kg⁻¹ soil (temporary N immobilization). In legume treatments, straw incorporation increased N₂ fixation from 60 to 80 %Ndfa. This "saved" native soil N and/or the added biologically fixed N was available to the subsequent wet season crop of lowland rice. Accordingly, N uptake by rice was 130, 175 and 190 mg pot⁻¹ following the transition season treatments "bare soil", "wheat straw" and the combination treatment "catch crop + wheat straw", respectively. The effect of such N-conserving practices on the yield of lowland rice is currently being validated at representative field sites in Nepal and will be discussed.

I.5 Socio-economic and ecological impacts of coral reef management in Indonesia

Afifi M.

Ruhr-Universität Bochum, Geographisches Institut, Universitätsstrasse 150, 44801 Bochum, Germany. (Mansur.Afifi@ruhr-uni-bochum.de)

The destruction of coral reefs occurring within the last decades has resulted in a great loss of opportunities to derive benefits from the resource. In many respects, coral reefs are a valuable resource for the people of Indonesia, in particular for the coastal communities. The resource plays significant roles as a habitat of fish, as a tourist attraction, and as a physical structure protecting coastal areas from abrasion. The Indonesian Government collaborates with non-government organisations (NGOs), universities and local people to implement a coral reef rehabilitation and management program (COREMAP). The program aims (1) to increase the welfare of local people and other stakeholders and (2) to improve the ecological condition of coral reefs. Consequently, this paper is intended to assess the impacts of the program on the welfare of local people and on the ecological condition of the coral reef. Extensive fieldwork was carried out in Lombok/Indonesia in 1999. Households are taken as basic units of analysis. Ecological conditions are assessed by analysing the trend of living coral cover in the research site and its vicinity during the last three years. Based on bivariate statistical analyses with chi square tests, the research shows a statistically significant relationship between participation of households in the program and their income. The result of econometric model analysis using a direct Ordinary Least Square (OLS) model (participation as a dummy variable) indicates that household incomes are affected significantly by the participation of households in the program at 99%. However, if a Heckman model is employed (in order to correct the selection bias problem; participation now appears as a continuous variable derived from predicted probability of participation) no statistically significant effect of the program on household income can be observed. In the latter two cases, the regression coefficient is negative, This indicates that the involvement of households in the program can reduce their income. So far the program does not appear to be able to increase the households' income substantially. One reason might be that the program is relatively new for the local people. Meanwhile, the ecological condition of the coral reefs around Lombok has deteriorated due to the El Niño phenomenon occurring in 1998. This led to a reduction of the living coral cover. However, since the implementation of the program a reduction of detrimental tendencies can be observed as a result of (1) the participation of the local people in law enforcement activities and (2) the development of environmentally sound additional sources of livelihood.

I.6 Site-specific evaluation of protected and non-protected forest stands in the Dominican Republic using GIS & Remote Sensing

Brötje, A., Erasmi, S., Kappas, M., Spehs, P.

*University of Goettingen, Inst. of Geography, Goldschmidtstr. 5,
37077 Göttingen, Germany (abroetj@mail.uni-geog.gwdg.de)*

The Dominican Republic is a Caribbean country dominated by mountain ridges with heights of up to 3175 m. Accordingly, there is a large variety of climatic conditions and natural habitats. Although deforestation in the Dominican Republic is not as complete as in neighboring Haiti, the country has already lost considerable parts of its forests, reducing the forest cover to roughly 25 % compared to an estimated 75 % in 1930. This is problematic as especially the tropical mountain forests of the island play an important role in protecting the slopes from erosion and regulating the water balance of the island's rivers, which originate in the mountains and provide the towns and agricultural areas in the basins with water. Forest maps and forest inventories are a prerequisite for sustainable forest use and for the protection of natural forest stands, but information about the forests of the Dominican Republic is scarce. In this study, medium to high resolution remote sensing data (e.g. Landsat TM & ETM, IRS, IKONOS, hyperspectral), topographic information (DEMs) and ground data (ASD FieldSpec) are to be used to extract information about forest cover, forest types and properties of protected and non-protected forest stands. Main test sites will be located in the upper catchment area of the Rio Yaque del Norte (Cordillera Central) and in the south-western Dominican Republic (Sierra de Baoruco, Sierra Martin Garcia). The aim is the development of an operational method for tropical mountain forest mapping. The resulting information is to be integrated in a geographic information system (GIS), facilitating information accessibility. The project is integrated in PROCARYN (Proyecto Manejo y Conservacion de la Cuenca Alta del Rio Yaque del Norte), which is financed by the KfW (Kreditanstalt für Wiederaufbau).

I.7 Reduced Impact Logging (RIL) in Tropical Moist Forest – Implications on long-term Growth & Yield

Glauner, R.¹, Huth, A.²

1 Institute for World Forestry, Leuschnerstr. 91, 21031 Hamburg (glauner@holz.uni-hamburg.de). 2 Department of Ecological Modelling, Permoserstraße 15, 04318 Leipzig

Three principal timber harvesting methods were compared with a “no harvesting approach” for tropical moist forest: Reduced Impact Logging (RIL) using tractors for timber extraction, Low Impact Logging (LIL) using air-borne yarding systems, and conventional tractor logging (CTL). The effects of the harvesting method on the long-term changes (120 years) of the annual allowable cut (AAC) were analyzed. We were using a process-oriented simulation model (FORMIX) in a GIS-environment for computing the various scenarios for the 55,000 hectares Deramakot Forest Reserve (DFR) in Sabah, Malaysia. The timber stands of DFR were inventoried during a terrestrial sampling in 1990 – 1992, and subsequently a forest management plan was elaborated. DFR was sustainably managed since then and sufficient field experience on logging damages, area losses, etc. is available. In our scenarios, we assumed a 40-years working cycle and applied a minimum diameter cutting limit of 60 cm diameter at breast height (dbh) for all species, 50 % damage (stem number) to residual stand for CTL, 30 % for RIL, and 20 % for LIL. Area losses due to yarding infrastructure amounted to 28 % for CTL, 12 % for RIL, and 4 % for LIL. The results clearly indicate that timber yields under LIL and RIL exceed CTL by far when longer planning periods are observed. However, CTL produces the highest short-term harvests. When aspects of sustainability are considered, only low and reduced impact harvesting methods can assure long-term forest productivity. Our findings are clearly in line with results from similar projects in other tropical areas and underline the need for applying appropriate harvesting techniques.

I.8 Agrarökologie-Nachhaltige Landwirtschaft-Ernährungssicherung

M. v. Mallinckrodt, F.

D-83339 Chieming, Germany, SARD Prize (www.sard-mallinckrodt.de).

Agroecology and sustainable agriculture are seen in this short paper/poster as condition for attaining lasting global food security. All three issues have been treated separately. History, definition and meaning of agroecology for soil fertility are elaborated. The term sustainable agriculture is discussed in relation to the 1992 Earth Summit and its preceding preparations by FAO and its disappointing follow up. The production of sufficient healthy and safe food for a growing world population is covered in the final chapter of the presentation. The importance of more sustainable agricultural practices in future years comes across consistently. Finally the short paper is providing a very useful bibliography of literature consulted for its writing.

I.9 Economic Assessment of Cereal-Legume Rotations in the Derived Savanna and Northern Guinea Savanna Agro-ecozones of Nigeria

Oyewole, B.¹, Schulz, S.¹, Tanko, R.²

1 International Institute of Tropical Agriculture, Ibadan, Nigeria. 2 National Animal Production Research Institute, Ahmadu Bello University, Zaria, Nigeria.

A crop rotation experiment over a 3-year period investigated the productivity and economic impact of legume-cereal rotations. Five crop treatments i.e. fallow, green manure, forage, grain, and dual-purpose (grain, forage) legumes were grown in 1- and 2-year rotations with maize and compared with continuous maize production with fertilizer applied at rates between 0 and 120 kg N ha⁻¹. Average yields and net returns varied greatly between sites. High cumulative yields and therefore high net returns were observed in the fertile DS site where cumulative yields ranged from 6 to 8 Mg ha⁻¹ (grain) and from 20 and 30 Mg ha⁻¹ (biomass). In contrast, in the degraded NGS site, yields of grain and biomass, in particular of maize, were considerably lower. The 1- and 2- year grain legume, 1- and 2-year dual-purpose with the 2-year forage rotations produced the highest cumulative net returns: between \$914 and \$1233 in the DS and between \$367 and \$765 in the NGS. Green manure and fallow treatments were the least profitable rotations at both sites. Continuous maize cultivation for 3 years was productive and profitable only in the DS where the 90 kg N ha⁻¹ treatment produced a cumulative net return (\$1014) similar to that obtained with grain legume rotations. At both sites intensive grain legume rotations are the economically viable production systems while continuous maize cultivation is possible only at the high fertility DS site. However, long-term data are required to assess the sustainability of these crop production systems.

I.10 Erfassung von Wasserhaushaltsparametern auf heterogenen Standorten im Bergland Nordthailands

Spohrer, K., Herrmann, L., Müller, J., Stahr, K.

*Institut für Bodenkunde und Standortslehre der Universität
Hohenheim, 70593 Stuttgart.*

Das Forschungsprojekt ist Teil des Sonderforschungsprogramm 564 "Nachhaltige Landwirtschaft und ländliche Entwicklung in Bergregionen Südostasiens" der Universität Hohenheim und geht auf einen gemeinsamen Forschungsantrag von Bodenkunde und Agrartechnik zurück. Im Untersuchungsgebiet, dem Mae Sa Noi-Watershed, ca. 30km nordwestlich von Chiang Mai, dominiert in Höhen zwischen 500m und 1000m der marktorientierte Litchianbau. Aufgrund des hohen Wasserbedarfs von Litchibäumen führt die gegenwärtige Bewässerungspraxis zu regionalen Wasserengpässen während der Trockenzeiten und zu ethnischen Konflikten um die Ressource Wasser. Die Hauptziele des interdisziplinären Projekts sind i) die Verbesserung der Bewässerungseffizienz bei Litchibäumen und ii) die Entwicklung von Methoden zur Modellierung des Wassergehalts in gesamten Wassereinzugsgebieten als Instrument für ein ressourcenschonendes Wassernutzungskonzept. Bodeneigenschaften, Klima und Vegetationscharakteristika variieren räumlich hauptsächlich aufgrund von Geologie, Topographie und Nutzung und bewirken so die Ausbildung eines heterogenen Standortmuster mit entsprechend unterschiedlichen Auswirkungen auf den Wasserhaushalt. Die Ausweisung von Flächen unterschiedlicher Wasserhaushaltsdynamik ist deshalb die Grundlage für die Optimierung der Bewässerungseffizienz und die Voraussetzung für Modellansätze auf der Feldskala. Ziel der ersten Projektphase ist es, die strukturbedingte Variabilität von Wasserhaushaltsparametern zu bestimmen. Folgende für den Wasserhaushalt eines Baumes relevanten Größen werden dabei untersucht: Die Bodenmächtigkeit, Hangneigung, Wurzelverbreitung und -dichte, sowie Niederschlagsvariabilität und potentielle Evapotranspiration in Abhängigkeit von der topographischen Position. Zusätzlich werden die für eine Bewässerungsplanung nach FAO-Standard nötigen Bodenparameter (verfügbarer Wassergehalt und maximale Wasserinfiltration) bestimmt. Die räumliche Variabilität einzelner Größen wird mit Hilfe eines geographischen Informationssystem erfaßt. Durch die Überlagerung der räumlichen Daten aller Einflußgrößen ist es dann möglich, Flächen gleicher Wasserhaushaltsdynamik auszuweisen. Für die Berechnung des verfügbaren Wassergehalts werden Teta-Psi-Funktionen aus Pedotransferfunktionen und ersten Meßergebnissen ermittelt und miteinander verglichen. Die maximale Wasserinfiltrationsrate soll durch eindimensionale Simulation bestimmt werden. Die nötigen Leitfähigkeitsfunktionen werden dabei aus den zuvor bestimmten Teta-Psi-Funktionen abgeleitet.

I.11 Technical Efficiency of Maize Production in Southwestern Ethiopia: a case of Jimma zone

Tsegaye, Y.¹, Berg, E.²,

1. Agriculture and Resource Management for Tropics and Subtropics (ARTS), University of Bonn. 2. Institute of Production and Environmental Economics, University of Bonn.

Ethiopia's agriculture is one of the most ancient in the world characterized by very traditional production technologies and is dominated by smallholders. The agricultural sector although employs around 85 percent of the labour force contributes only 50 percent of the GDP. Its productivity is one of the lowest and even showing a decreasing trend bringing a decline in per capita cereal consumption. In this paper an attempt is made to investigate if there are potentials of maize productivity gains in Jimma zone, Ethiopia by improving the technical efficiency of the farm households. To this end, a Cobb-Douglas type stochastic frontier production function was specified. It was found out that the technical inefficiency is a significant component of the composed error term of the stochastic specification, at a significance level of 2.5 percent. And about 50 percent of the variation in maize production in Jimma zone is explained by the difference in technical efficiency among maize producing farmers. Ownership of livestock, participation in extension program and access to infrastructure were found to differentiate farmers in attaining different levels of technical efficiency in maize production. Therefore, improving the extension and infrastructure access of farmers in Jimma zone can help in increasing the technical efficiency of maize production.

I.12 Strategic Approaches for Agricultural Mechanization Planning using Linear Programming - Case Study of Wolenchiti Farmers, Ethiopia

Dilnesaw, A.C.¹, Gaese, H.²

1 University of Bonn (dilnesaw@yahoo.com). 2 Institute of Technology in the Tropics, Cologne.

In order to suggest an optimum farm planning to increase the profit per unit farm area for the Wolenchiti farmers of Ethiopia and in order to select economically profitable technology packages, this particular study was conducted. A linear programming technique (LP) was used to determine the optimum farm planning. Analysis was carried for 2 ha land area and three technology models. The problem was written in a standard LP format by identifying an objective function and different constraints viz. land, labor and capital. It was then solved on a computer using the LP software. It was revealed that for the Model-A, if farmers adopt the suggested optimum plan then they would expect a profit of 943.62 Br. more profit than the present profit. Similarly, if the farmers adopt Model-B technology level and Model-C technology level and use for their production then they could get profit of 6555.12Br. and 6384.56Br. respectively and when these are compared with the current use then the profit are about 3 times more. This is because of the overcome of labor shortage in Model-B and -C and the increase of yield of the crops due to the utilization of these new technology Model-B and -C. From the result it is clear that Model-B would give the maximum benefit. These results are sufficiently attractive to justify the need for dissemination of Model-B technology level and institutional support systems including credit and the appraisal of the risks involved in order to identify potential constraints to its widespread adoption. That means it would be better if the local authority could try to disseminate this technology to the Wolenchiti farmer.

I.13 Curriculum for organic farming in the tropics

Hauser, M., Vogl, C.R., Freyer, B.

Institute of Organic Farming (IfÖL), University of Agricultural Sciences (BOKU), Gregor Mendel Straße 33, A-1180 Vienna, Austria.

Organic farming is gaining rapid acceptance in many tropical and subtropical countries. While the Institute of Organic Farming (IfÖL) already offers undergraduate training that addresses various aspects of organic farming in temperate zones, attempts to develop a curriculum that focuses on tropical and subtropical environments was initiated only recently. The demand from students and professionals from different countries and the interest of actors within BOKU provided the impetus for taking the necessary first steps. However, organic farming in tropical and subtropical environments is based on special economic, social, cultural, legislative and technological preconditions; organic farming is also characterised through a high degree of complexity and diversity. Training programs must pay tribute to these conditions, cutting across many different disciplines. The entire program is organised in three phases: (i) general introduction to technical, economic and social aspects of organic farming; (ii) organic land use systems and the facilitation of attempts to scale up and extend organic farming; (iii) field project in close cooperation with partners in the south. In each phase of the curriculum different pedagogical approaches will be used, ranging from rather linear presentations to more interactive designs such as workshops and seminars. The lecturing team will comprise local and international experts. During the summer term 2001, the first three courses were held. However, the development of a curriculum that aims to be complementary to already existing international endeavors is a long-term project. It requires a clear vision, strategic plans, resources, international cooperation, proper coordination, concerted action and the openness to learn. The challenge ahead is hence to further develop the curriculum so that it reflects actual needs, while at the same time overcoming existing barriers constraints.

I.14 Conditions for Successful Wildlife Co-management: The Case of Golini-Mwaluganje Community Wildlife Sanctuary in Kenya

Mburu, J., Birner R.

*University of Goettingen, Institute of Rural Development, Waldweg
26, 37073 Goettingen.*

Co-management of natural resources has received increasing interest on the international level in recent years. Co-management seeks to create negotiated agreements between state and local communities and therefore offers a possibility to overcome conflicts over resource exploitation. However, evidence from empirical cases suggests that certain conditions must be in place in order to make co-management a feasible and viable option. The proposed study explores these conditions and factors that promote successful co-management, taking the case of wildlife in Kenya as an example. The study applies a combination of theoretical concepts of the New Institutional Economics (NIE), including property rights analysis, transaction costs economics and collective action theory. The field work for the presented results was conducted in the wildlife dispersal areas of Shimba Hills National Reserve in the coastal region of Kenya, where a stratified random sample of 66 GCWS members and non-members, and seven stakeholder groups of GCWS were interviewed. The study empirically analyses under which conditions co-management can promote harmonisation of conflicting interests of the various stakeholders and hence enhance sustainable management of wildlife. Among other factors, adequate representation, low costs (transaction costs) of participation, direct benefits, absence of political influence and homogeneity of the local communities have been identified as key determinants of successful wildlife co-management.

I.15 GIS-based survey and nutrient fluxes in a mountain oasis of Oman

Nagieb, M., Siebert, S., Buerkert, A.

Institute of Crop Science, University of Kassel, Steinstr. 19, 37213 Witzenhausen, Germany, (mahernagieb@hotmail.com).

Surprisingly little is known about the land use system and nutrient fluxes in oases of the Arabian Peninsula. To overcome these knowledge gaps, field surveys were conducted in 1999 and 2000 at Balad Seet (23.19 °N, 57.39° E, 970m), a traditional mountain oasis of Northern Oman. The oasis system investigated comprised 650 inhabitants distributed in 80 households who rented land in and out. The 392 tiny fields were divided into six terrace systems totaling 4.6 ha to which a similar number of palm gardens covering 8.5 ha have to be added. Due to price/cost relationships between imported cereals and locally produced meat, the large majority of the land was dedicated to feed ruminants, whereas for their own consumption farmers bought grain externally. The application of manure from about 200 small ruminants and 10 cattle led to annual nutrient inputs of up to 300 kg N, 120 kg P and 400 kg K ha⁻¹ in addition to considerable N inputs from mineral fertilisers. However, the distribution of these inputs varied greatly throughout the year and across fields, which was reflected in a highly heterogeneous distribution of negative versus positive nutrient budgets. The scarcity of irrigation water led to a selective distribution towards the prime agricultural land in the immediate proximity of the houses. The determination of nutrient and water use efficiencies at the field level requires further research but it is evident that the sustainability of the current land use system heavily depended on external incomes of the farmers' extended families.

I.16 Non-destructive dry matter estimation of *Alhagi sparsifolia* vegetation in NW China through GIS-based kite photography

Siebert, S., Gries, D., Runge, M., Buerkert, A.

Institute of Crop Science, University of Kassel, Steinstr. 19, 37213 Witzenhausen, (ssiebert@wiz.uni-kassel.de).

In the Taklamakan desert of NW China repeated dry matter determination of field-grown *Alhagi sparsifolia* shrubs by manual ground measurements is a time consuming process. Colour aerial photography was used as an alternative to monitor the surface covered by these shrubs in a field of 96 x 66 m. First and second order polynomial regressions between dry matter data of 50 individual shrubs and their respective canopy area, determined from an aerial picture taken from a kite at about 250 m height, allowed to automatically calculate dry matter of all remaining shrubs covered by the photograph ($r^2 = 0.92$ to 0.95). The use of non-linear dry matter estimations from the photograph required an automatised separation of single shrubs and conglomerations of bushes growing together taking into consideration canopy size and canopy shape. The developed methods may have broad applications for basic and applied research in marginal agro-ecosystems with sparsely growing plants.

I.17 Management Constraints to the Development of Tropical Fruit Trees

Janssens, M., Pohlan, J.

*University of Bonn, Institut fuer Obst- & Gemuesebau, Abt.
Tropischer Pflanzenbau*

The present development trend of tropical fruit trees would be even higher if some critical management constraints were to be solved. Among the most crucial problems yet to be solved there are: the lack of ready available knowledge on the pomology of available cultivars, the shortage of good propagation material, the implementation of simple grafting and rooting techniques for the lesser known species, the appropriate release of pest predators, the mechanic handling of harvest and pruning, and finally the optimal application of weed control. Combining animal husbandry with sound orchard management ought to be given new consideration. Superimposing fertigation upon animal x fruit systems will be a challenge for the coming years.

I.18 Intercropping Chickpea (*Cicer arietinum*), Soybean (*Glycine max*), Lentil (*Lens esculenta*) with selected vegetables.

Prasad, P.

University of Bonn, Institute für Obst und Gemüsebau, Auf dem Hügel 16, 53121 Bonn

Vegetables which are relatively wider spaced in comparison to cereals and pulses can be intercropped with legumes to obtain higher nutritional yield as well as efficient use of the space. A field experiment on intercropping of two vegetables (Sweet Corn and Paprika) with chick pea, soybean and lentil were conducted during April - October, 1999 at the Research Station of Land Technik, Steinweg, Bonn, Germany (50° N, 7.5° E, 48 masl, soil PH 6.9). There were 21 treatments comprising of 7 sole croppings of 2 different spacings of Sweet Corn (60X25, 120X50 cm), 2 different spacings of Paprika (60X 50, 120X50 cm), Soybean (25X25), Chickpea (20X20), Lentil (10X8) and intercroppings of these legumes with the two different spacings Sweet corn and Paprika in a Randomised Complete Block Design to evaluate the yield advantage of legumes with Sweet Corn and Paprika. Sweet Corn represents the test-species for long, straight and quick growing vegetable, Paprika represents the small statured slow growing vegetable species. In intercropping treatments with the Sweet Corn (60X25), Paprika (60X50), 1 line of chickpea, 1 line of soybean, 2 lines of lentil were grown separately in between each Sweet Corn and Paprika rows. In wider spacing of Sweet Corn (12X50), Paprika (120X50), 3 lines of chickpea, 5 lines of chickpea, 3 lines of soybean and 8 lines of lentil were grown separately in each rows with Sweet Corn and Paprika. Results show that intercropping of chickpea, soybean with Sweet Corn (60X25) reduces height, number of leaves, number of branches and finally the yield of individual legume plants, where as lentil plants were unaffected in growth and yield in comparison to the sole crop. The seed yield reduction in single chickpea, in single soybean plants were 5 and 4 times respectively in comparison to their sole crop. Seed Yield per hactre of chickpea , soybean , lentil in the intercrop with Sweet Corn (60X25) were reduced 20 times, 10 times, 5 times respectively in comparison to sole crop due to reduction in plant number in hactare and suppression effect of Sweet Corn on chickpea and soybean but not on lentil. The cob yield of Sweet Corn per hectare were unaffected due to legumes intercrop as compared with Sweet Corn sole crop. In intercropping of the legumes with wider spacing of Sweet Corn (120X50) the growth and yield of legume plants were unaffected in comparison to their sole crops. The cob yield in Sweet Corn per ha were affected in Sweet Corn + chickpea 5 lines and Sweet Corn +lentil 8 lines about half of the Sweet Corn sole crop (120X50). Intercropping of chickpea, soybean, lentil with 2 different Sweet Corn spacings (60X25, 120X50) resulted in higher Land Equivalent Ratio.

Symposium II

Agriculture and Climate Change

II.1 N-cycling in tropical ecosystems: Implications of gross nitrification rates on N₂O emissions in rainforests of Northeastern Australia

Breuer, L.¹, Butterbach-Bahl, K.²

*1 Justus-Liebig-University Giessen, Heinrich-Buff-Ring 26-32, 35392
Giessen, Germany. (lutz.breuer@agrar.uni-giessen.de).*

*2 Fraunhofer Institute for Atmospheric Environmental Research, IFU,
Kreuzeckbahnstr. 19, 82467 Garmisch-Partenkirchen, Germany.*

By using the barometric process separation technique (BaPS) for determination of gross nitrification rates in soils for a set of intact soil cores taken on the Atherton Tablelands, Australia, it could be shown, that (i) gross nitrification rates are strongly correlated to soil temperature, and (ii) that simultaneously determined N₂O-emissions depend heavily on nitrification. Measured rates of gross nitrification rates in these tropical rain forest sites were up to 20 fold as compared to nitrification rates in temperate forest soils. Based on our results it can be deduced, that the annual N-turnover rate via nitrification is up to 1500 kg N ha⁻¹ in the tropical rainforest soils of northeastern Australia.

II.2 Recent Climate Change in China and possible impacts on Agriculture

Schaefer, D.

Department of Geography, Mainz University, Germany.

The increased concentration of greenhouse gases in the atmosphere due to human activities like the combustion of fossil fuels and agricultural production tends to warm the surface air temperature and results in general changes of the climate system. Commonly accepted, the global average surface air temperature has increased since the latter half of the 19th century, with a global warming over the 20th century at a rate of 0.6 °C. Globally, the 1990s were the warmest decade, 1998 the warmest year of instrumental record. Human health, ecological systems and socioeconomic sectors are sensitive to changes in climate and its variability; strong links are noticed between the variability of climate and the agricultural productivity. China is socioeconomically dependent on agriculture and therefore the climate diagnosis is very important in order to describe and explain climate variability. This paper discusses the spatial and temporal variabilities and trends of temperature and rainfall in China and possible impacts on agriculture. Homogeneous monthly temperature and rainfall data of 165 official stations scattered over China were collected and analysed with different statistical methods in order to describe and explain the temporal and spatial variability of climate in China. Strong increasing trends of temperature can be observed in almost all parts of China and all seasons. Strongest warming trends can be found during autumn and winter. The increase is for instance in Shanghai 1.12 °C for the long observation period 1871-1999, whereas the global average surface temperature shows an increase of 0.60 °C in the same period. Precipitation shows a more complex structure: increasing and decreasing trends were computed. Besides the interannual variability of rainfall is very high. Completing the paper, possible impacts on agriculture due to the changes of climate in China are discussed, for example possible changes of the productivity of agriculture. The findings are compared with global trends and discussed against the background of the recently published reports of IPCC and former reports about regional impacts of climate change.

II.3 The impact of forecast climate changes on the productivity, range, and sustainability of Coconut (*Cocos nucifera* L.).

Allen, E., Hornung R.

Plant Biotechnology Laboratories (PBL), Department of Agricultural Sciences, Faculty of Life Sciences, Imperial College at Wye, University of London, Wye, Ashford, Kent, TN25 5AH, UK.

The latest IPCC report forecasts that in the coming 50 years there will be highly significant changes in the global temperature regime, concentration of CO₂, and precipitation regimes over all areas of the world, with the most significant changes occurring over mid and high latitudes. The latest models indicate that there will be an effective increase in the size of the thermal zone of the tropics; which will enable tropical plant species to grow in areas previously beyond their physiological limits. Of particular concern for coconut production are the forecast increases in sea level and the impacts of this on the littoral growing zone that coconut so successfully exploits. This zone, in many areas of the world, is forecast to be inundated within the next 50 years, however the net impact of climate change may be positive, for global coconut production, as new areas are predicted to become suitable for coconut growth. It is clear that with the changes in environmental conditions, new ecotypes will be required.

Mutation breeding has been identified as an efficient way of creating new cultivars, but it is suggested that existing non-domesticated ecotypes should be conserved for potential breeding programmes. This should be done in tandem with continuing work on clonal propagation of coconut. Moreover with the available effective forecasting and modelling of future environmental changes, there appears to be a clear opportunity to maintain coconut production in newly arising marginal areas by effective use of these technologies.

Acknowledging the significant amount of time and long-term funding required for the development of new cultivars, the combination of modelling applied to breeding programmes should allow a more strategically effective resource use in coconut producing areas.

It is concluded that coconut will benefit from forecast climate changes, in terms of increasing the geographical range of coconut. This is in spite of the forecast problems associated with sea-level change.

II.4 **Supplementation of feed with saponin-containing fruits to reduce methane emissions from ruminal fermentation in vitro**

Hess, H.D.^{1,3}, Kreuzer, M.¹, Díaz, T.E.², Lascano, C.E.³, Carulla, J.E.⁴, Soliva, C.R.¹, Machmüller, A.¹

1 Institute of Animal Sciences, Animal Nutrition, ETH Zurich, ETH Zentrum/LFW, CH-8092 Zurich. 2 National Program of Animal Physiology and Nutrition, Corpoica, Bogota. 3 Tropical Grass and Legume Project, CIAT, Cali. 4 Department of Animal Production, National University of Colombia, Bogota, Colombia.

Ruminants in the tropics are mainly fed with forage and crop residues of low quality and, consequently, methane release per unit of animal product is relatively high. Some ruminal methanogens are known to be associated with protozoa, and saponin-rich fodder plants have been shown to reduce protozoa population by up to 80%. There is a variety of tropical plants differing in content and type of saponins. Nevertheless, their effects on rumen fermentation and efficacy to reduce methane is still widely unexplored. Thus, a first experiment was performed to compare the effects of the dietary supply of three saponin-containing tropical fruits (*Sapindus saponaria*, *Enterolobium cyclocarpum*, *Pithecellobium saman*) on rumen fermentation in vitro. The diets were evaluated with faunated and defaunated rumen fluid with an eight-fermenter Rumen-Simulation Technique (Rusitec) system. Only the diet containing *S. saponaria* significantly decreased protozoa count by 54% and daily methane release by 20% compared to the unsupplemented control. Defaunation suppressed methane release by 43% on average of all diets, but the effect of *S. saponaria* against methane was even higher in defaunated (29%) than in faunated rumen fluid (14%). These results suggest that saponins or other constituents of *S. saponaria* act directly against rumen methanogens whether associated with protozoa or not. To follow-up this initial experiment the effect of increasing dietary proportions of *S. saponaria* in the diet (0 to 14%) on rumen protozoa and methanogenesis was evaluated in a second Rusitec experiment. Total protozoa count was not affected when low proportions of *S. saponaria* (2 to 6%) were included in the diet. However, with high proportions (12 and 14%) protozoa count was reduced by over 50%. Also daily methane release depended on the proportion of *S. saponaria*. When the level of *S. saponaria* was increased from 0 to 8%, methane release gradually declined by up to 10%. A further increase in *S. saponaria* proportion had no additional depressing effect on methane release. These studies demonstrated that the fruits of the tropical multipurpose tree *Sapindus saponaria* supplemented to a tropical diet as used here have the potential to significantly reduce methane release from ruminal fermentation.

II.5 Odour Pollution in the Environment: Development of a Measuring System.

Yuwono, A.S., Hamacher, T., Boeker, P., Schulze Lammers, P.

*Institute of Agricultural Engineering, University of Bonn, Nussallee 5,
53115 Bonn.*

Attention to odour as an environmental nuisance is growing as a result of the awareness of people's need for a clean environment. Odour is seen as a serious problem in the environment. As a consequence, efforts to abate this problem are necessary in order to maintain the quality of the environment, or even to improve it. In this framework, an understanding of the odour problem, the origin of odour, the appropriate measuring systems and the abatement methods become very important aspects. The odour concerned are unpleasant odours that are often become an environmental nuisance. Thus, comprehensive knowledge on this problem is important. For this reason, we propose an on-line system for measuring odours in the environment using an array of quartz crystal microbalance (QCM) sensors. A series of laboratory tests of the sensor array for measurement of various odour gases showed that a frequency change was generated in the quartz as a response to the odour present in the environment. This result leads to a provisional conclusion that in future the use of this sensor array might be an alternative besides the existing costly conventional chromatography methods and olfactometry.

II.6 Climate Variation, Spatial Food Insecurity and Integrated Rural Poverty: a review of evidence from Cameroon

Molua, E.L.

*Georg-August University, Department of Agricultural Economics,
Platz der Goettinger Sieben 5, 37073 Goettingen, Germany,
(emolua@uni-uao.gwdg.de).*

Climate is the primary determinant of agricultural productivity. The adaptive capacity of farming systems and households to changing climatic conditions is dependent on a wide array of factors, ranging from legal and institutional issues to the severity of climate extremes. In Cameroon, food production and/or consumption is a major economic activity, which depends on the performance of seasonal rain. The semi-arid region in the north is known for high temperatures and hot dry conditions for most of the year, and intermittent short rainy seasons with less than average rainfall. The frequency and extent of drought conditions in this region have, however, tended to increase in recent years. The rest of the country in the south is hot and humid, characterized by abundant rainfall. Erratic rainfall distribution with destructive torrential down pours, have recently been reported. This paper examines the potential impact of these climate variations on food availability and the implications for rural poverty alleviation in Cameroon. The paper reports year-to-year variability in climatic conditions and reveals that variation in precipitation and temperature has affected agricultural production and food supply in the northern part of Cameroon which accounts for about 40% of the population. The combined consequences of these processes has been a noticeable impact on food security. Short term food scarcity has become an important social concern in the region. Though climate variation has diminished northern Cameroon's comparative advantage in food production, however, farmers in the southern region with a relatively better climatic condition for agriculture have not complemented food supply to the north. They have failed to capture the economic benefits resulting from the interregional shifts in comparative advantage and associated employment. The paper concludes that increasing climate variation and a potential change in future climate are expected to influence crop and livestock production, input supplies and other components of agricultural systems in Cameroon. The ultimate impact on agriculture and food availability will depend upon the magnitude of change in climatic variables and the accompanying indirect environmental effects. The extent of the impact would, however, depend on how the agricultural sector and civil society are able to adapt to the associated changes. The challenge of improving food security in the country should include actions aimed at improving the procurement and food marketing system as well as policy measures aimed at improving the adaptive capacity of the farming systems and households to weather anomalies.

II.7 Longterm measurement of soil respiration in an old-growth neotropical rainforest (La Selva, Costa Rica) and the effects of environmental factors

Schwendenmann, L.¹, Veldkamp, E.¹, Mackensen, J.², Brenes, T.³, Gerold, G.⁴

1 Institute of Soil Science and Forest Nutrition, University of Göttingen, Germany. 2 UNEP, Nairobi, Kenya. 3 La Selva Biological Station, Costa Rica. 4 Department of Landscape Ecology, Institute of Geography, University of Göttingen, Germany.

Tropical forests play an important role in the global carbon budget. It is therefore critical to understand how the carbon budget of tropical forests will react to changes in environmental conditions. For this reason "CARBONO", a long term, landscape scale project was set up at La Selva Biological Station in Costa Rica. The main objectives of this study are (i) to present results of the long-term measurement of soil respiration under old-growth neo-tropical rainforest in the Atlantic zone of Costa Rica and (ii) to evaluate the effect of environmental parameters on soil CO₂ efflux. We measured soil respiration on three Inceptisol plots (old alluvial terraces) and three Ultisol plots (highly weathered residual soils) using an infrared CO₂ analyzer. In April 1998 respiration measurements were started at bi-weekly intervals from 8 permanent soil chambers per plot. At the same time we measure soil CO₂ concentrations at 5, 20, 40, 75, 150, 250 and 350 cm depth using a GC. In addition, controlling environmental factors like soil temperature and soil moisture were determined. Over the first 2-yr period of measurement (April 1998 to April 2000) CO₂ emissions on Inceptisol sites ranged from 116.2 mg C m⁻² h⁻¹ to 128.8 mg C m⁻² h⁻¹. During this period soil respiration was around 40 % higher on the Ultisol site, ranging from 140.2 mg C m⁻² h⁻¹ to 183.9 mg C m⁻² h⁻¹. Spatial differences were related to fine root biomass, carbon and phosphorus concentration but also to soil water content and soil CO₂ storage. Seasonal differences of soil respiration in this wet tropical environment were related to soil water content. Soil respiration followed a parabolic pattern through the range of soil water content measured. With increasing volumetric water content soil respiration decreased but soil air CO₂ concentration and CO₂ storage remained high. Soil water content did not inhibit CO₂ production but possibly inhibited diffusion.

II.8 Linking microbial activities and nitrogen availability to nitrous oxide fluxes in forest-derived pasture sites in the humid tropics of Brazil

Wick, B.¹ Veldkamp, E.¹ Zamboni de Mello, W.², Keller M.³

1 University of Goettingen, Institute of Soil Science and Forest Nutrition, BÜsgenweg 2, 37077 Germany, (bwick1@gwdg.de). 2 Universidade Federal Fluminense, Rio de Janeiro, Brazil. 3 University of New Hampshire, Durham, NH 03824, USA.

We studied soil N-cycling, enzyme activities and N₂O fluxes along a chronosequence of pasture sites of 4 month up to 60 years following deforestation near Santarem, Para, Brazil. Microbial biomass-N (CFE-technique), nutrient mineralizing enzymes (protease, β-glucosidase, acid and alkaline phosphatase), total and inorganic N-pools, net mineralization and nitrification, and N₂O (closed chamber method, ECD chromatography) were measured once during the dry and wet season in 32 pasture sites and 4 primary forest control sites. Average N₂O-fluxes in all pasture sites were lower than in the forest sites. Deforestation and establishment of pasture sites resulted in a decrease of N₂O-emissions during the wet season by about 80 % from 128 (g N₂O-N m⁻² h⁻¹ at the primary forest sites to 29 (g N₂O-N m⁻² h⁻¹ at the 4 month old pasture sites. N₂O fluxes during the dry season followed the same trend but emissions were negligible by comparison. No apparent age trend in N₂O emissions with both pasture age and total organic nitrogen and carbon could be found. Data on N-cycling rates (microbial biomass, soil nutrient mineralizing enzymes, N-mineralization) will be used to explain the changed emissions of N₂O.

II.9 Land suitability for cowpea production as influenced by climate variability in Northeast Brazil

Gaiser, T.

University of Hohenheim, Inst. für Bodenkunde und Standortlehre, D-70593 Stuttgart.

The Northeast of Brazil is characterized by a semi-arid tropical climate with high spatial and temporal variability of precipitation, partly caused by so-called "El-Nino" events. Some climate scenarios for this regions predict a decrease of total annual precipitation within the first half of this century. Based on historical rainfall series of various stations in the states of Ceara and Piaui, the land suitability index for cowpea, one of the most important staple and cash crops for the local markets, has been calculated for various climate scenarios for both states using the land suitability classification method proposed by FAO. Upscaling of the clas-sification results and visualization has been performed by SPICE (Soil and Land Resources Information System for the States of Piaui and Ceara). The results indicate that rainfall distribution influences signifi-cantly the land index. The use of time series allows the calculation of the production risk per region and the identification of areas where cowpea production is most vulnerable to climate variations.

II.10 N₂O-emission from different tropical rain forest sites in the region of the "Wet Tropics" Queensland, Australia

Kiese, R.¹, Breuer, L.^{1,2}, Papen, H.¹, Butterbach-Bahl, K.¹

*Fraunhofer Institute for Atmospheric Environmental Research,
Kreuzeckbahnstr. 19, 82467 Garmisch-Partenkirchen, Germany,
(kiese@ifu.fhg.de). 2 Justus-Liebig-University Giessen,
Heinrich-Buff-Ring 26-32, 35392 Giessen, Germany.*

Tropical rainforests are one of the major single sources (14-23 %) for N₂O emissions, in the global atmospheric N₂O budget. As an important radiatively active trace gas N₂O contributes at least 5% to the observed global warming at present. Though there is no doubt about the high proportion of N₂O emissions from tropical rainforest soils to the global atmospheric N₂O budget, these values are only based on a relatively small number of data. To further improve these estimates temporally as also spatially highly resolved measurements of N₂O emissions from tropical rain forest soils at the Atherton Tablelands (700-100m) and Coastal Lowlands (30-100 m) in NE-Australia were carried out during different seasons (wet, dry, intermediate) in the years 1997-2001. In the study area, highest N₂O emissions were recorded during wet season conditions due to a strong positive correlation of N₂O-emissions and rainfall events. During this period of time N₂O fluxes at Coastal Lowland sites were with a mean value of 189 µg N₂O m⁻² h⁻¹ approximately two-fold higher compared to N₂O fluxes at the Atherton Tablelands. This principle difference in the magnitude of N₂O fluxes is related to higher temperatures and precipitation at the lowland sites, leading to increased rates of mineralization, nitrification, denitrification and associated N-trace gas emissions. Furthermore, closer C/N-ratios of the litter and soil top layer at the lowland sites, supporting high rates of microbial C and N turnover are a further explanation of higher N₂O fluxes at Coastal Lowlands. At all sites N₂O fluxes dropped down below 10 µg N₂O-N m⁻² h⁻¹ during the dry season mainly due to limitation in soil moisture. All data were used for the improvement of the biogeochemical PnET-N-DNDC model, which will be used in combination with a GIS for calculating N₂O-fluxes on a regional scale.

Symposium III

Alternatives to Slash-and-Burn

III.1 Forest Fires to Future Famines? Enhancing livelihoods and ecosystem services for farmers in the tropics.

Fernandes, E.

*Department of Crop and Soil Sciences, Cornell University, NY
14853.*

The cheapest and most common method of converting forests to commercial or subsistence agriculture involves slashing and burning the forest. Traditionally, subsistence farmers cleared and burned small patches of forest, and cultivated a variety of crops for several years. As yields declined due to a combination of soil nutrient depletion and increased weed, pest and disease pressures, farmers cleared and cropped a new area of forest while the previously cropped land was left fallow for 30 to 60 years. Unlike temperate fallows, the secondary succession on previously cropped areas was often enriched with selected species and managed for a variety of non-timber forest products and services. In the past, this type of shifting agriculture sustained large numbers of forest dwellers in the tropics. In many tropical countries, rapidly increasing populations, the lack of employment and income generating opportunities and the resulting demand for agricultural land has resulted in the reduction of fallow periods to less than five years. The large-scale clearing of primary forests for the establishment of plantation crops and pastures and subsistence cropping systems characterized by short fallows, is resulting in the rapid degradation of crop and pastureland, significant increases in greenhouse gas fluxes and a major increase in smoke-related human health problems. In recent years, the scale of forest fires has also resulted in major revenue and trade losses for the countries affected by the fires. Unsustainable slash and burn agriculture is resulting in food insecurity due to landscape level degradation of natural resources and the loss of biodiversity and agroecosystem services. This paper presents examples and data from selectively logged forests and a range of tree based systems from the humid tropics on productivity, household incomes, C sequestration and biodiversity. I also discuss the performance of agroforestry prototype systems to rehabilitate the productivity and agrobiodiversity of degraded pastureland in the Amazon.

III.2 Land-use in a mulch based farming system of small holders of the Eastern Amazon

Vielhauer, K.¹, Denich, M.¹, Sá, T.D.de A.², Kato, O.R.², Kato, M.doS.A.², Brienza Jr., S.², Vlek, P.L.G.¹

1 Center for Development Research (ZEF), University of Bonn, Germany. 2 Agroforestry Research Center of the Eastern Amazon (Embrapa Amazônia Oriental), Belém - PA, Brazil

Burning is a commonly used method to clear land for cropping, especially in regions with shifting cultivation. Mostly it is combined with shortening of fallow periods due to population growth. Both factors are the principal causes of declining soil fertility, and they are symptomatic for Eastern Amazonian agriculture. Within a project of ZEF, University of Bonn and Embrapa Amazônia Oriental, Belém, Brazil, alternatives to counteract these problems are being developed. Yet, shifting cultivation as a whole is to be maintained as a system. Motor mechanized mulching technologies were developed with which land clearing is done without burning; by cutting and chopping the tree-rich fallow vegetation and leaving behind a mulch layer of chips, mostly smaller than 2 cm. Besides the primarily desired preservation of organic matter and mineral nutrients, land preparation can be carried out at any time of the year, because mulching does not depend on the dry season, as burning does. Enriching the fallow vegetation with fast growing trees is supporting the effect of mulching. As compared to a natural fallow, with a biomass accumulation of about 10 t ha⁻¹ year⁻¹, the accumulation rate of enriched fallow vegetation is more than doubled during the first 2 - 3 years. Putting the technologies into practice the demand on differently behaving nutrient dynamics in mulch-based systems has to be met on one side; on the other side alternative ways of land utilization are offered, due to the acquired flexibility by fire-free land preparation. New crop-fallow scenarios emerge from both, whilst the basic principles of shifting cultivation are kept: I) Fallow biomass increase by enrichment reduces the fallow period from 4 - 6 years to 2 years. II) Slowly released nutrients of the mulch layer allow an additional cropping period. This reduces the act of land preparation by half. III) Highly demanding crops can be planted at the end of the cropping period if low mineral fertilizer input is desired. IV) The detachment of the dry season permits planting of crops more ideally with view to climate and to market demands. V) Semi-permanent cash crops can be integrated into the crop rotation.

III.3 The change from shifting cultivation to alternative farming systems in Sumatra

Scholz, U.

Justus-Liebig-Universität, Dept. of Geography, 35390 Giessen.

Up to the beginning of the 20th century shifting cultivation in connection with slash and burn activities has been the dominating farming method in large parts of Sumatra. Since then the situation has been changing drastically. Today, most of the farmed land is used for alternative farming systems, whereas the share of shifting cultivation has dropped to less than 5%. The following factors have been especially responsible for this remarkable development: 1) The rapid spread of commercial bush and tree crops, especially rubber. Introduced to Sumatra by European estate companies around 1910 the cultivation of the rubber tree was quickly adopted by the local shifting cultivation farmers who used their fallow land for the planting of rubber seedlings. The same happened with other bush and tree crops like coffee, spices, and damar, resulting in an agroforestry-like type of landuse. Today more than 60% of the agriculturally used area of Sumatra are covered with bush and tree crops. 2) The transfer of rice production from upland areas to irrigated lowlands. As more and more of their fallow land was occupied by rubber trees, the local farmers had to look for alternatives to shifting cultivation in order to produce the necessary rice for their daily food. The solution was a gradual shift to irrigated wet rice cropping. Fortunately, this shift was strongly supported by the Indonesian intensification program for lowland rice after 1968, the so-called 'Green Revolution' which not only solved the countries' food problem but also contributed to a rapid decrease of shifting cultivation with slash and burn practices. The described development not only resulted in a completely altered physiognomy of the agricultural landscape but also exhibited a variety of economic, social and ecological consequences, such as: 1) economic consequences: transition from subsistence to a market oriented farm economy, dependence on world market prices, improved job and income opportunities, and risk reduction by diversification. 2) social consequences: growing individualization through the penetration of commercialization and monetarization, weakened position of traditional village authorities, e.g. clan leaders, and far reaching alterations of land tenure regulations. 3) ecological consequences: slowing down (albeit not stopping!) of rain forest destruction, and improved sustainability of the whole farming system.

III.4 Improved Tree Fallows in Zambia: Do initial testers adopt the technology?

Keil, A.

*Institute of Rural Development, Georg-August University
Goettingen, Germany.*

In eastern Zambia, traditional bush fallows have been shortened by population pressure and are not sufficient for soil fertility restoration any more. Following subsidy removal, the use of mineral fertilizer has sharply declined in the 1990s. Both factors have led to decreasing soil fertility and, hence, low maize yields which threaten food security. Improved Fallows (IF) using leguminous trees are a low cash-input agroforestry practice of soil fertility replenishment. The International Centre for Research in Agroforestry (ICRAF) began on-farm experimentation in 1992/93, and by 1996/97 roughly 3,000 farmers spontaneously tested the technology. A survey was conducted to assess the adoption of IF by those early testers, and to identify factors which influence the adoption decision and determine the scale of the practice. Furthermore, farmer experiences with the technology and implications on other parts of the farming system were explored. Seventy-five percent of testers have adopted the technology which shows that IF are a suitable practice under the given conditions. Adopters practice the technology at 42% of its potential scale; land and/or labor availability limit expansion. Adoption is positively influenced by the availability of land and labor resources. A non-linear relationship was found between adoption and wealth status: Ninety-three percent of farmers in the 'fairly well-off' category with ample land resources but limited alternatives of soil fertility restoration adopted IF, as opposed to only 59% of 'very poor' and 'well-off' farmers. Land scarcity and risk aversion constrain adoption among the very poor stratum, while well-off farmers have more profitable options of soil fertility maintenance, such as mineral fertilizer and manure. The scale of the practice is larger in a conducive edaphic environment. Furthermore, it depends on per capita land endowment which determines the share of land that can be fallowed. Increased maize yields are the primary benefit derived from IF, allowing farmers to sell some of the additional maize produced. Thus, apart from enhancing maize consumption, IF also lead to increased cash income. To facilitate the expansion of the practice, future research should emphasize IF options to reduce land and labor requirements, such as intercropping and species which can be direct-seeded.

III.5 Management of Secondary Forests as an Alternative to Slash and Burn in Northern Thailand and Nepal

Schmidt-Vogt, D.

Dept of Geography, South Asia Institute, Heidelberg University.

Slash and burn cultivation, which is more commonly referred as swidden cultivation in the literature on tropical Asia, is still a widespread land use practice in the Eastern Himalayas and the adjoining mountain ranges of mainland Southeast Asia. The authorities of the countries in this region regard swidden cultivation as undesirable and pursue therefore a policy of converting it to other forms of land use, especially permanent farming. The dynamics of land use change vary considerably from country to country and not in every case is permanent cultivation considered to be the best possible alternative to swidden cultivation in the ecological setting of the montane regions of South Asia and Southeast Asia. Another alternative is the use and management of secondary forests on fallow swiddens. The potential of this alternative is discussed within the regional context of Northern Thailand and Eastern Nepal. In Northern Thailand, swidden cultivation has been the mainstay of ethnic minorities in the hills until the middle of the 20th century, but is now in the process of being rapidly replaced by permanent farming systems. Some of the traditional swidden cultivation systems practiced in Northern Thailand have been capable of maintaining a cover of secondary forests, which are valuable from both an ecological and an economic point of view. Ways of managing these forests are discussed as an alternative to both, the continuation of shifting cultivation and its replacement by permanent farming. Swidden cultivation in Nepal has been widespread in the past, but is now largely confined to Eastern Nepal. In contrast to Northern Thailand, swidden cultivation in Nepal is carried out not as the main agricultural activity but to supplement production on permanent fields. The future of swidden cultivation in Eastern Nepal is currently being debated in connection with the establishment of the Kanchangjunga Conservation Area. Fallow management systems and agroforestry systems based on secondary forests on fallow swiddens are considered as alternatives to the continuation of swidden cultivation.

III.6 Transaction Costs and Innovation in Peasant Agriculture

Batista Rodrigues, J.G.¹, Hurtienne, T.²

*1 University of Goettingen. 2*Zentrum fuer Entwicklung Forschung (ZEF), University of Bonn.*

This paper deals with the introduction of technological innovation as an alternative to slash and burn in the Northeast of Pará. The analysis is based on the theory of new institutional economics which deals with the asymmetry of information between the principal and the agent. In the case presented here, transaction costs are caused through asymmetrical information between a research organization (SHIFT-Capoeira / EMBRAPA) and the rural families (peasants), due to the introduction of a technological innovation. In this context, the opportunistic behavior of the agents (peasants) in relation to the principal (SHIFT-Capoeira) is analyzed before and after the contract, which is the basis for the introduction of the innovation. The work is based on qualitative interviews held with the peasants (limited to family farms), who participate in the SHIFT project, and with the researchers involved. The research was conducted in the municipality of Igarapé-Açu in the Federal State of Pará in the north of Brazil.

III.7 Botanical composition and forage quality of enriched and traditional pastures in northeastern Pará, Brazil

Camarão, A. P.¹, Rodrigues Filho, J. A.¹, Rischkowsky, B.², Hohnwald, S.², Schultze-Kraft, R.³

1 *Embrapa Amazônia Oriental, Belém, Brazil.* 2 *Georg-August-University of Göttingen, Germany.* 3 *University of Hohenheim, Stuttgart, Germany.*

The integration of cattle into the traditional slash-and-burn cycle in the humid tropics, where secondary vegetation (“capoeira”) plays an important role to recuperate the soil and maintain biodiversity, might be an alternative to meliorate the land-use system. Two alternatives are being tested in comparison to the traditionally separated grass-only (*Brachiaria humidicola*) pasture (PT), namely a *B. humidicola* pasture enriched with controlled re-growth of the natural capoeira (PC) and one enriched with legumes, *Cratylia argentea*, *Chamaecrista rotundifolia* var. *grandiflora* and *Arachis pintoi* (PL). The nine experimental plots of 0.34 ha each were established on a small-holder field in the municipality of Igarapé-Açu (47°30'W/1°2'S) which had been cultivated with annual crops (maize, cassava) for 1.5 years preceded by the slash-and-burn of a 12- year capoeira. Initially 3 and later 2 crossbred male yearlings with an initial weight between 165 and 250 kg were rotated among the 3 replications of each treatment. Forage availability was measured at the beginning of each grazing period and the botanical composition of the diet estimated by micro-histological analysis of faeces collected at the end. In the first phase of the experiment (22.3.2000 –1.3.2001) the average period of grazing and resting were 23 and 46 days, maintaining a mean stocking rate of 1.5 animal units (1 AU = 450 kg) ha⁻¹. The average daily weight gain (g) was 475, 520 and 590 on PC, PL and PT, respectively. The availability of forage was 5.7, 5.0 and 5.3 t total dry matter (DM) ha⁻¹, of which 2.1, 1.8 and 1.9 t DM ha⁻¹ were stems, 0.9, 0.9 and 0.9 t DM ha⁻¹ leaves and the rest was litter on PC, PL and PT, respectively. In all treatments, grass dominated the cattle diet. Legumes contributed 14.6 % to the diet on PL, Capoeira species 36.8% on PC. In total 29 different Capoeira species were found in the faeces of the animals. These preliminary results show that both alternative types of pastures allowed to maintain a higher stocking rate than 1 AU ha⁻¹, which is common for the Amazon region. However, the daily weight gains were highest on the well managed PT.

III.8 Crop and soil variability in traditional and modern Mayan maize cultivation of Yucatan, Mexico

Graefe, S.¹, Arias Reyes, L.M.², Buerkert, A.¹

1 *Institute of Crop Science, University of Kassel, Steinstr. 19, 37213 Witzenhausen, Germany.* 2 *Centro de Investigación y Estudios Avanzados, Merida, Mexico, (s.graefe@gmx.net).*

Mixed cropping of local germplasm of maize (*Zea mays* L.), beans (*Phaseolus spp.*) and squash (*Cucurbita spp.*) on calcareous soils is characteristic for the traditional 'milpa' shifting cultivation system in the south-eastern Mexican state of Yucatan. In the last decades this ancient Mayan system has come under pressure. Milpa production has been strongly affected by population increases resulting in shortened fallow periods and decreasing soil fertility. Increasing demands of a market-driven economy, government efforts to reduce regular forest burning and rapid modernization processes led to the introduction of improved crop genotypes and mineral fertilizers. To document the status quo of milpa agriculture and to determine its possible future role in Yucatan's agriculture six case studies have been conducted. Two farmers in three villages were categorized into 'modern' and 'traditional' to analyze their cultivation practices on the basis of soil, plant and management parameter. For both, modern and traditional farmers, the use of local maize landraces and mixed maize-bean-squash cropping was common on the heterogeneous mosaic of Lithosols and Luvisols. However, 'modern' farmers tended to intensify the more homogeneous and deeper soils through the use of improved varieties, mineral fertilizers and herbicides. Traditional farmers, in contrast, continued the cultivation of a range of local maize varieties and additional food crops satisfying different household needs. The study revealed that there still exists a wealth of traditional knowledge among milpa farmers and it largely depended upon the socio-economic condition of the family unit whether a farmer used modern technologies or relied upon traditional practices. Under the given circumstances of this location-specific production system partial adoptions of external inputs are not able to displace the adapted traditional cultivation strategies on a large scale. Despite its reliance on regular burning of secondary vegetation milpa agriculture should be regarded as a sustainable form of land use which allows to exploit marginal areas and maintain genetic resources for a number of associated plant species.

III.9 Slash-and-burn versus slash-and-mulch in Eastern Amazonia -Brazil- farmer's perception

Kato, M.S.A., Oliveira, C.D.S., Leal, E.C., Lima, J.P.V., Kato, O.R.

*Embrapa Amazônia Oriental, Belém, PA, Brazil,
(skato@cpatu.embrapa.br).*

The technique of slash-and-mulch land has been adapted and validated, during the last seven years, as an alternative to the traditional slash-and-burn agriculture in Northeastern of Pará State, Brazil, as part of a Brazilian/German initiative (Embrapa Amazônia Oriental/ITA- University of Göttingen and ZEF-University of Bonn) as part of the SHIFT Program. A number of outstanding studies were carried out and are underway adopting a researcher managed on farm research approach, focusing on agronomical and ecological aspects associated to this system, which is being faced as a way of reducing the nutrients losses and the undesirable emissions to the atmosphere associated to burning, and of increasing the fertility of the soil through the organic matter accumulation, consequently increasing crop productivity. Trying to fulfill the gap of understanding the perception of the local family agriculture farmers, with respect to the new technique, a study was started in the community of São João, municipality of Marapanim, Pará State, involving six small farmers which are comparing the performance of maize and cassava, in 1/3 ha plots prepared by the slash-and-burn (50%) and slash-and-mulch (50%) techniques. Farmer's perception is being assessed through weekly discussions with the farmers about the advantages/disadvantages experienced along the cycle and raising suggestions to improve the system; by using participatory appraisal techniques; and by comparing technical coefficients with the data raised along the study.

III.10 Passion fruit under slash-and-mulch land preparation- a sustainable crop?

Kato, O.R.¹, Kato, M.S.A.¹, Silva, W.R.¹, Cordeiro, C.J.¹, Vielhauer, K.²

1 *Embrapa Amazonia Oriental, Belém-PA-Brazil.* 2 *ZEF, Uni. Bonn, Bonn, Germany.*

The passion fruit crop (*Passiflora edulis*) became an alternative for the small holders to diversify their production and to increase their income, in part of the Northeastern Pará State, Brazil, and particularly in the municipality of Igarapé Açu. At present, it is the most important semi-permanent crop in this area, where is exclusively cultivated as a cash crop. The slash-and-burn land preparation associated with intensive mechanization use is contributing to increase soil degradation, reducing the potential of regeneration of the secondary vegetation and consequently affecting the biodiversity, and the nutrient availability, as well as exposing the soil to surface erosion. Aiming at evaluating the performance of this crop under the slash-and-mulch system, as a way to mitigate the problems associated to the traditional system, three land preparation methods are being tested, i.e. slash-and-burning; slash-and-burning + plowing; and slash-and-mulching, with and without intercropping. The work is being carried out under a participatory approach, with the farmers taking part of the decision making process. Besides of production data, are also being monitored: fruit quality, incidence of pests and diseases, socio economic aspects, and recently, biophysical aspects. The socio economic assessment is being approached by applying semi structured questionnaires, to some passion fruit producers, trying to understand the process of introduction of this region, how is it affecting their financial budget, and how sustainable is being the crop under the traditional system.

III.11 Participatory research to optimize agroforestry systems in Eastern Madagascar: Improved fallows and intensified orchards as an alternative to traditional slash-and-burn

Nambena, J.

University of Heidelberg, Germany, (nambena@dts.mg).

The Eastern escarpment of Madagascar, characterized by a hot, humid climate, a mountainous relief and originally covered with rainforest, is inhabited by the Betsimisaraka. They practice traditional slash-and-burn to produce rice, cassava, ginger and cultivate some bananas, coffee and fruit trees in mixed orchards. Population growth accelerates forest destruction and the shortening of fallow lengths entails soil and vegetation degradation with declining yields.

For agricultural improvement it is essential that local farmers recognize the danger caused by their practices and accept to change them. Analyzing their perception shows that the satisfaction of basic needs encounters important difficulties. Many peasants mention that frequent use of fallows for annual crops and lack of rejuvenation and maintenance for perennial cultures lead to decreasing harvests for the main consumption and cash crops. Everybody complains that forest disappearance forces them to buy construction wood. This growing consciousness induces a certain interest in agricultural innovations, 70 % of the farmers claim already planting leguminous species (mainly *Tephrosia*) to restore fertility. Suggestions for agricultural development are inspired by indigenous innovations elsewhere: Improved fallows might accelerate soil fertility rehabilitation, increase firewood availability and provide timber for light constructions. The intensification of the orchards responds to farmers' financial needs ensuring a regular income from the beginning: Improved planting and maintaining techniques increase yields of existing cultures, new annual and perennial cash crops can be introduced and agroforestry species fulfill both ecological and productive functions, with timber trees encompassing even a kind of long term capital reserve. All the interviewed peasants (24 in two villages) agreed to participate in on-farm-trials to adapt these propositions to the local ecological conditions and their own needs and capacities. Their main interest lies in timber trees, followed by fast growing species and leguminous hedgerows; the average surface of the trial fields is 0.5 ha per farmer. Though research has only begun, the optimization of agroforestry systems seems promising to solve important problems the peasants are faced with: declining soil fertility, scarce wood supplies and insufficient income sources. The farmers' engagement for the field trials confirms their interest in new vegetable, fruit and agroforestry species.

III.12 Role of mycorrhiza and hedgerow in a sustainable cropping system in the tropics.

Fagbola, O.¹, Osonubi O.²

1 Department of Agronomy, University of Ibadan, Ibadan, Nigeria. 2 Department of Botany and Microbiology, University of Ibadan, Ibadan, Nigeria.

A field investigation over a two-year period involving the use of *Glomus clarum*, a vesicular arbuscular mycorrhiza fungi (AMF) and mulching with pruning from two hedgerow species, using a split-split plot design with three replicates was conducted at the University of Ibadan teaching and research farm. The effects of these treatments were evaluated on the nutrient uptake and yield of cassava (*Manihot esculenta* Crantz). The hedgerows used were *Leucaena leucocephala* and *Senna siamea*, which are nodulating and non-nodulating legumes. It was observed that inoculation with AMF significantly contributed to the total biomass yield and nutrient uptake of cassava in both first and second year of the experiment. AMF-inoculated cassava was higher than the non-AMF inoculated. The system of planting; alley- and non-alley-cropped was also significantly different. The non-alley-cropped cassava was lower compared to the alley-cropped in terms of total biomass yield and nutrient uptake. Biomass yield of cassava was in the order AMF-inoculated, alley-cropped > AMF-inoculated, non-alley cropped > non-AMF inoculated, alley-cropped > non-AMF inoculated, non-alley cropped. Pruning from the hedgerow were not applied in the first year of the investigation. In the second year, the contribution of pruning to the yield of cassava was negative, though not statistically significant. Application of pruning from the hedgerows as mulch was negative in the order *Leucaena* < mixture < *Senna* (mixture was pruning from *Leucaena* and *Senna* mixed 1:1). Although, the contribution of pruning from the hedgerows were negative, the fragile tropical soil will require the nutrient recycling power of the hedgerows through deep-growing roots and litters from the pruning for a sustainable productivity.

III.13 Reclamation of abandoned pastures for crop cultivation in northeastern Pará, Brazil

Guimarães, C.M.¹; Rodrigues Filho, J.A.²; Camarão, A. P.²; Veiga, J. B.²; Rischkowsky, B.³; Vielhauer, K.⁴; Schultze-Kraft, R.⁵

1 CNPq/DTI, Scholarship. 2 Embrapa Amazônia Oriental, Belém, Brazil. 3 Georg-August-University of Göttingen, Germany. 4 ZEF, Bonn, Germany. 5 University of Hohenheim, Stuttgart, Germany

In the last decades about 25 to 30 million ha of Amazonian primary forest have been converted into pastures and cropland. More than 50 % of these pastures are considered to have reached an advanced state of degradation. In northeastern Pará, where practically no primary forest remained, secondary vegetation, called "capoeira", is the dominant vegetation cover. The vigorous re-growth of Capoeira during the fallow period allows the regeneration of the land after cultivation of annual crops. Compared to the fallow following annual crops, the regenerative potential of degraded unproductive or abandoned pastures is lower and the regeneration process much slower. Thus, this study proposes to facilitate the recuperation of abandoned pastures for productive use by enriching the re-growing capoeira with leguminous trees and shrubs. Leguminous species of different growth forms were selected according to their ecological adaptation, their potential for rapid growth and for high accumulation of biomass. The experiment was set up in March 2001 on a 8-year old *Brachiaria humidicola* pasture in the municipality of Igarapé-Açu, Pará, that had been abandoned for the last 2 years. Ten species, namely *Acacia mangium*, *Sclerolobium paniculatum*, *Leucaena leucocephala*, *Chamaecrista rotundifolia*, *Flemingia macrophylla*, *Stylosanthes guianensis*, *Pueraria phaseoloides*, *Mucuna pruriens*, *Arachis pintoii*, and *Desmodium ovalifolium*, are being tested in pure stands and combinations adding up to 24 treatments, including the two controls, unchanged pasture vegetation and capoeira re-growth without enrichment. As additional factor fertilization with phosphorous (60 kg P₂O₅ ha⁻¹) is considered. Each of the 48 treatments is being tested in 12 m x 12 m plots in four replications (192 plots) using a randomized block design on a total area of 3.3 ha. The following parameters will be measured: chemical and physical soil properties and biomass before planting, after 6 months, one year and two years, vegetation cover and botanical composition before planting and in six months intervals, resprouting of the natural vegetation from roots and trunks, the rate of establishment and survival of the planted species, height and diameter of trees and shrubs every two months, mass and decomposition rate of litter.

III.14 Clearing methods and its effects on nutrient losses, erosion and growth of replanted oil palm

Ross M.¹, Herzog, H.²

1 Kali und Salz GmbH, Bertha-von-Sutthner-str. 3, 34131 Kassel, Germany. 2 Humboldt University, Albrecht-Thaer-Weg 3, 14195 Berlin, Germany.

In co-operation with the Palm Oil Research Institute field trials for the assessment of clearing methods 'Burning' (Bu), 'Zero Burning' (Zbu) and 'Zero Burning' + pulverization (ZBuP) as well as natural vegetation (NV), legume cover crop (LC) and a fallow plot (Fa) were conducted in respect to soil chemical and microbiological parameters. Simultaneously erosion and vegetative growth of the cover crop and the new oil palms were monitored. The surface run-off and erosion sediment were decisively influenced by the biomass remaining on the surface. In the treatment BuHerb. ('Bu' + herbicide application) the highest surface run-off (361 l m^{-2}) and sediment erosion ($6,1 \text{ t ha}^{-1}$) was measured. The surface run-off and sediment erosion was lowest in the treatment ZBuP + LC with 111 l m^{-2} and 785 kg ha^{-1} , respectively, which emphasised the positive effect of mulching a cleared stand in respect to erosion protection after clearing. The comparison between Bu and ZBu demonstrated that ZBu generally has had a positive effect on minimising erosion risk. Calculated nutrient losses by erosion derived by surface run-off, sediment erosion and corresponding nutrient concentrations were double in Bu compared to ZBu treatments. Measurements of soil chemical parameters revealed a distinct influence of clearing on these parameters. Contents of soil organic carbon (TOC) and total nitrogen contents (Nt) were increased in all Bu treatments directly after clearing showing at the end of the trials levels above pre-clearing. Soil organic carbon and total nitrogen contents increased at a slower rate and reacted later on clearing. A corresponding increase in soil microbial biomass and dehydrogenase activity could not be observed directly after clearing which indicated pH dependent effects. Contents of cations in the soil reacted differently on clearing and treatments. While K-contents decreased after clearing, a temporary increase of Mg- and Ca-contents could be observed. Considering the entire trial period a deterioration of the cation nutrient status in the soil was measured. The P-contents were not negatively affected by clearing. The P-release by the cleared biomass was slower and more continuous in the ZBu treatments. Soil water measurements showed a more balanced course of soil water contents and longer periods of higher matrix potentials in the ZBu treatments. High nutrient losses by percolation particularly resulted during the first six months after clearing. Changes in seepage water concentrations could be explained by the burning of the biomass and the resulting nutrient release as well as by precipitation distribution.

III.15 Soil fertility changes under different organic matter management of shifting cultivation in the central Amazon

Steiner, Chr.¹, Lehmann, J.², Nehls T.¹

1 Institute of Soil Science, University of Bayreuth, 95440 Bayreuth, Germany. 2 College of Agriculture and Life Sciences, Department of Crop and Soil Sciences, Cornell University, Ithaca, NY 14853, USA.

Soil nutrient contents and availability are generally low in the highly weathered and acid upland soils of the central Amazon. Additionally, high precipitation and permeable soils lead to large and rapid water percolation into the subsoil. In natural forest ecosystems, extensive and deep root systems ensure a closed nutrient cycling even under those high leaching conditions. In agro-ecosystems, however, nutrient losses by leaching can be very substantial due to usually higher nutrient loads and a less efficient root system. The result is a low nutrient use efficiency of applied fertilizers. Previous studies of the so-called Terra preta in the Amazon had revealed that a main component of the organic carbon in these soils was derived from charcoal. In a field experiment, we study the management of a highly weathered Xanthic Ferralsol by using charcoal, animal manure amendments, litter and compost.

We suppose, that charcoal amendments will reduce leaching of applied mineral fertilizer, and thus increase crop production. Charcoal amendments to soil will improve crop nutrition without large nutrient losses by leaching, - the Terra preta nova.

III.16 An integrated research and development initiative towards sustainable management of family agriculture in Eastern Amazonia

Sá, T.D.A.¹, Kato, O.R.¹, Kato, M.S.A.¹, Brienza Junior, S.¹, Camarão, A.P.¹, Vilar, R.R.L.¹, Costa, F.A.², Vielhauer, K.³, Denich, M.³, Rischkowsky, B.⁴, Hurtienne, T.³

1 Agroforestry Research Center of the Eastern Amazon (Embrapa Amazônia Oriental), Belém - PA, 2 Center of Superior Amazon Studies (NAEA), Federal University of Pará, Belém - PA, Brazil. 3 Center for Development Research (ZEF), University of Bonn. 4 Institute of Animal Production in the Tropics and Subtropics, University of Göttingen, Germany

The Brazilian Agricultural Research Corporation (Embrapa) is carrying out an integrated project towards a sustainable future for the family agriculture-small farms in its Agroforestry Research Center of the Eastern Amazon (Embrapa Amazônia Oriental), headquartered in Belém, Pará State. The Eastern Amazon region, where planned rural settlement took place around a century ago, is an important study region due to its typical characteristic of humid tropical agriculture and the experiences of a systematic colonization process that transformed the region abruptly into an anthropogenic landscape. Nowadays, similar processes are found along the Trans-Amazon highway. Holding a joint venture with German institutions (mainly ZEF-University of Bonn; and University of Göttingen), under the umbrella of the bilateral SHIFT Program) and other local Amazonian and Brazilian institutions, including also regions, institutions and research groups from other countries, the activities are converged in a project named: "Improvement, validation and valuation of fallow management technologies for sustainable land use in Eastern Amazonia", which is being carried out from August 2000 to July 2004. The project consists of the following subprojects: 1) development, improvement and test of equipment used for fire-free land preparation in Eastern Amazonia, 2) improvement and validation of fire-free land preparation in Eastern Amazonia, 3) improvement and validation of alternative fallow techniques in Eastern Amazonia; 4) integration of bovine livestock in the fallow vegetation cycle in Eastern Amazonia; and 5) Socio-economic evaluation and valuation of technologies of fire-free land preparation and fallow enrichment. The main objectives of this joint initiative are: 1) to draw and implement technological alternatives towards improving environmental impacts and farmers life quality in the Brazilian Eastern Amazon, focusing on secondary vegetation management, and 2) to offer technical support and appropriate indicators to the formulation of public policies directed to promote sustainable development in the agricultural sector of the Brazilian Eastern Amazon. This could open up for a transversal use of these technologies in other agricultural scenarios or in other regions.

III.17 Effect of slash-and-mulch on productivity of grass-only and grass–legume pastures in northeastern Pará, Brazil

Bittencourt, P.S.¹, Veiga, J.B.², Rischkowsky, B.³, Vielhauer, K.⁴

1 CNPq/DTI, Scholarship. 2 Embrapa Amazônia Oriental, Belém, Brazil. 3 Georg-August-University of Göttingen, Germany, 4 ZEF, Bonn, Germany.

The slash-and-burn of secondary vegetation (“capoeira”) is a common practice of establishing pasture in traditional smallholder production systems in northeastern Brazil, state of Pará. Nutrient losses and accidental fires are the most common environmental problems associated with this practice. This study compares two methods of land preparation (slash-and-burn and slash-and-mulch) on the establishment and productivity of “quicuío” (*Brachiaria humidicola*) and “braquiaraço” (*B. brizantha*) pasture, pure and in mixture with two legumes combinations (*Leucaena leucocephala* + *Arachis pintoi* and *Cratylia argentea* + *Arachis pintoi*). The experiment is being carried out on a smallholder farm in Igarapé-Açu (sandy Yellow Latossolo soil; Ami climate) since March 2001. The mulch was obtained by triturating a 8-year old “capoeira” vegetation and spreading it over the area. Only the legume *Cratylia argentea* will be planted by seedlings. The experimental design is a completely randomized block, with three replications, each plot measuring around 0.3 ha (53 m x 50 m). The legume combinations were established in 4 m rows in a distance of 8 m. During planting phosphorus fertilizer (60 kg P₂O₅ ha⁻¹) was applied on all plots. Three steers will be assigned to each treatment and grazed in a rotational system (21-day grazing / 42-day rest), using the replications as paddocks. The experiment is in its establishment phase. It is planned to measure the dynamics of the mulch layer, soil properties (OM, chemical and physical parameters) and of the botanical composition comparing the treatments for at least three years. The main experimental responses will be: forage production and quality and animal gains (per head and per area).

III.18 Farmer-assessment of three soil fertility improving technologies in the Brong Ahafo Region of Ghana

Anthofer, J.¹, Kroschel, J.², Gyamfi, E.³, Loos, H.³

1 University of Kassel, Institute of Crop Science, Steinstraße 19, 37213 Witzenhausen, Germany, (juergen.anthofer@t-online.de). 2 University of Hohenheim, Institute of Plant Production and Agroecology in the Tropics and Subtropics, 70593 Stuttgart, Germany. 3 Sedentary Farming Systems Project (SFSP), German Development Co-operation (GTZ), P.O.Box 473, Sunyani, Ghana.

In 2000, a case study was conducted in the Brong Ahafo Region of Ghana to examine farmers' experiences using *Mucuna pruriens* var. *utilis* as an improved short season fallow which was introduced to farmers three years ago. The survey was carried out in three districts of the Brong Ahafo Region of Ghana, each representing a different agro-ecological zone: Atebubu (Guinea Savannah), Sunyani (Derived Savannah) and Asunafo (Semi-Deciduous Forest). Farmers' experience on *Mucuna* was qualitatively compared with the use of chemical fertilizers and animal manure which are the other two soil fertility improving technologies. On an average, *Mucuna* was used by farmers since 2.2 years while experiences with the use of animal manure and mineral fertilizer exist for 3.2 years and 5 years, respectively. According to farmers' opinion, the application of animal manure and mineral fertilizer is more effective in short-term yield improvement. *Mucuna* fallow was ranked higher for its long-term effects on soil fertility and on weed control, its availability at village level, low cost, and low labour demand. On average, farmers had to weed their crops once to twice per season in *Mucuna* based systems while they weeded twice to three times if mineral fertilizer or animal manure was applied. However, uncontrolled bushfires are seen as a high threat to the success of the *Mucuna* fallow especially in the Savannah Zone, being one reason for the very low area under *Mucuna* cultivation. Only 0.4 ha per farm was dedicated to *Mucuna* while animal manure and mineral fertilizer was applied on 0.5 ha and 1.5 ha per farmer, respectively. Farmer-to-farmer dissemination of the *Mucuna* technology was lowest at 8.8% while more than 30% of the farmers who had applied animal manure or mineral fertilizer had received their information about the respective technology from other farmers. Restricted availability of animal manure (64%) and high costs of mineral fertilizer (88%) are the main reasons not to use these technologies.

III.19 Problems of Socio-Economic and Environmental Evaluation of Alternatives to Slash-and-Burn

Hurtienne, T.

*ZEF, University of Bonn, Walter-Flex-Str. 3, 53113 Bonn, Germany.
NAEA, Campus Il do Guamá, 66.075-980 Belém - PA, Brazil,
(thomas@nautilus.com.br).*

The paper gives a critical overview of the state of the art of research done in the humid tropics on evaluating alternatives to slash-and-burn, and discusses the validity of the underlying explanatory models. The paper includes also a discussion of some of the first results of collective research work done in the Eastern Amazon within the SHIFT programme, executed by ZEF / NAEA. Special attention will be given to the problems in linking private and social cost-benefit analysis.

III.20 Alternatives to slash-and-burn agriculture: a research approach for the development of a chop-and-mulch system

Denich, M.¹, Vielhauer, K.¹, Abreu Sá, T.D.², Lücke, W.³, Vlek, P.L.G.¹

1 Center for Development Research (ZEF), University of Bonn, Germany. 2 EMBRAPA Amazônia Oriental, Belém, Brazil. 3 Institute for Agricultural Engineering, University of Goettingen, Germany.

The introduction of research-based innovations into traditional land-use systems is difficult, as examples from agroforestry have shown. It can take years to decades until a new agricultural practice has been adopted by the farmers and often the innovations are not very well aligned with the problems and concerns of the farmers. Therefore, in our search for alternatives to the traditional slash-and-burn land preparation (in the context of the SHIFT project "Secondary forests and fallow vegetation in the agricultural landscape of the Eastern Amazon region") we opted for field experiments carried out on small-farmers' land in an old agricultural landscape of the Amazon region. To achieve our objective we follow a phased plan: (i) diagnostic research (ii) technology development and prototype evaluation and (iii) adoption-oriented research. During the diagnostic project phase we identified the critical needs for improvement, focusing on nutrient dynamics, fallow regeneration, and fire prevention. Then, instead of designing a completely new land-use system, we aimed at modifying those components of the traditional system which cause or introducing those components which have the potential to prevent degradation processes due to intensified land use. Alternative technologies were developed as a set of modules including the development of a tractor-driven bush chopper for fire-free land clearing and mulching, enrichment planting with fast-growing leguminous trees to improve the biomass production of the fallow vegetation, shifts in the cropping sequence as well as the screening of modern low-input crop varieties under mulch conditions. Adoption of these modules is flexible, leaving the farmer in control of the innovation process. The adoption-oriented research phase is currently underway and assesses the willingness of the farmers to adopt the farming system improvements. Participatory on-farm research facilitates the adoption process.

III.21 P-dynamics in slash and mulch system in south-east Sulawesi, Indonesia: Impact of different age of fallow vegetation

Abdullah, L.¹, Kuehne, R.F.¹, Vlek, P.L.G.²

1 University of Goettingen, Institute of Agronomy and Animal Production in the Tropics, Department of Agronomy in the Tropics, Grisebachstrasse 6, D-37077 Goettingen, (labdull@gwdg.de). 2 Centre for Development Research (ZEF), Walter-Flex-Strasse 3, D-53113 Bonn, Germany.

Our objectives were to assess the effects of differential age of fallow vegetation and amount of mulch application on the soil microbial biomass P, soil available P and P uptake by maize as a test crop in southeast Sulawesi, Indonesia. Within fallow vegetation as main plots, three levels of mulch consisting of: control (no mulch = M0), 2.2 kg m⁻² (leaves 29% and wood 71%) for three years fallow vegetation (F3) and 9.3 kg m⁻² (leaves 10% and wood 90%) for seven years fallow vegetation (F7) = (M1) and M2 = 2M1 were set up as split-plots with three replicates. Mulching was carried out a week before seeding. Maize cv. Hybrid CP1 was grown on 2m x 2m plots (50 plants plot⁻¹) without soil tillage. The soil was fertilized (150 kg N ha⁻¹ and 60 kg K ha⁻¹), but no mineral P was applied. To test the effect of roots on soil parameters, plots without maize were included. Surface soil (0-10 cm) was sampled at 0, 2.5, 5 and 10 weeks after planting. Maize shoots were harvested at 10 weeks. The results showed that mulch application increased significantly ($P < 0.05$) the shoot dry weight (SDW) of maize over control by 70% (M1) and 140% (M2) for F3 and 27% (M1) and 110% (M2) for F7. Total P-uptake increased over control by about 230% (M1) and 570% (M2) for F3, and 52% (M1) and 260% (M2) for F7. The application of younger material (F3), from F3 doubled P-uptake of maize as compared to the older one (F7). Application of 3-years-old fallow vegetation increased Bray P of unplanted plots over control particularly after 5 weeks and resulted in a higher Bray P than that of older fallow. However, the 7-years-old fallow vegetation did not increase significantly ($p > 0.05$) Bray P concentration in the soil. The main factor influencing the parameters was the age of fallow vegetation. F3, which consisted of easily decomposed organic material (due to high leaf portion) contributed to the highest SDW, P uptake and soil available P. Combination between F3 and M2 resulted in the best SDW and P uptake.

III.22 Crop yield benefits from soil organic carbon accumulation and implications for alley cropping

Steinmüller, N.

*University of Hohenheim, Institute of Plant Production & Agroecology
in the Tropics & Subtropics, 70593 Stuttgart, Germany,
(steinmue@uni-hohenheim.de).*

In alley cropping systems, the on-site production of organic fertilizers in competition with food crops has frequently caused food crop yield losses under marginal growth conditions. The objective of this research were (i) to quantify crop yield benefits from soil organic carbon (SOC) accumulation by organic fertilisers and (ii) to develop a new approach of alley cropping evaluation. Carbon balances were calculated with literature data of organic fertiliser studies focusing on long-term experiments from tropical and temperate climates. A direct input-output assessment in six field experiments of 40 to 152 years resulted in an average farmyard manure (FYM) C recovery of 28% (14-50%). The C budget was also determined indirectly by multiplying soil accumulations of FYM-C with relative crop yield responses to increasing SOC. Annual FYM applications during 18 to 128 years increased SOC by a mean factor of 0.9 in two tropical and of 8.7 in 13 temperate experiments. These enrichment factors were in line with another assessment by the ratio between FYM humification rates and mineralisation rates of labile SOC. Multiplying these factors by the percentage C yield response to increasing SOC amounts of 3.6% in temperate and 10.3% in tropical climates resulted in corresponding C recoveries of 31% and 12%. Fifteen experiments of direct comparisons with FYM indicated that C recoveries for green manure or straw are 50% less. These high C losses of organic fertilisers suggest to separate the assessment of intercropping benefits from organic fertiliser losses in future alley cropping research.

III.23 Secondary forest management in the Eastern Amazon: The hydrological perspective

Wickel, A.J.; Vielhauer, K., Van de Giesen, N., Sá, T.D.de A., Vlek, P.L.G

ZEF, University of Bonn

With the introduction of fire free land preparation by means of mulching a need has risen for the assessment of ecological impacts of this new technology and to secure the sustainability of this modified land use system. In July 2000, as a part of the Studies of Human Impact on Forests and Floodplains of the Tropics (SHIFT) program, a new study on the impacts of slash-and-burn versus slash-and mulch agriculture on the water and nutrient dynamics has been initiated. The research objective of this sub-project, is to establish which changes occur in the water and nutrient dynamics at various spatial levels within a small watershed (16 km²) when farmers move from slash-and-burn to slash-and-mulch (land preparation with a bush chopper) fallow clearing technique. The main aims are: to obtain a closed water balance for a set of experimental watersheds with different fallow clearing techniques, to measure total nutrient and sediment outflow, and to measure and model the main water and nutrient flow paths.

Symposium IV

Natural Resource Degradation and Desertification

IV.1 Desertification - a signal of inadequate resources management

Akhtar-Schuster, M., Jürgens, N.

*BIOTA Southern Africa - S06 -University of Hamburg, Ohnhorststr.
18, 22609 Hamburg, Germany (Akhtar-Schuster@botanik.uni-
hamburg.de)*

Desertification is the direct signal of inadequate resources management, and is defined as '... land degradation in arid, semi-arid and dry subhumid areas resulting from various factors, including climatic variations and human activities'. This definition was adopted by the UN Conference on Environment and Development (UNCED) in Agenda 21, in Rio de Janeiro, Brazil, in June 1992. However, a redefinition could be useful in order to counteract any attempts to define the naturally, rainfall induced decline in biomass production as desertification. Lacking standardised research methods for the analyses of dryland eco-systems are still one of the major obstacles for the understanding of the dryland resources potential, hindering the worldwide comparability of desertification research results. A classification of dryland degradation indicators does not exist. The scaling of degradation indicators is indispensable for the development of an 'early warning system' and the definition of 'thresholds' for possibly irreversible degradation processes. And lastly, scientific investigations into human induced and weather related impacts on the biophysical environments are often intermingled. The projects BIOTA Southern Africa (Biodiversity Monitoring Transect Analysis in Southern Africa) (BMBF) and IMPETUS West Africa (An integrated approach to the efficient management of scarce water resources in West Africa) (BMBF) have started conducting research on developing standardised methods for dryland research and on the sustainable utilisation of biodiversity in Africa. The environmental impact of desertification shows the inevitability of the action to establish the UN Convention to Combat Desertification (UN CCD) in 1994/1996, as a third fundamental convention on environmental changes, thus, closing the gap between the UN Framework Convention on Climate Change (UN FCCC) and the UN Convention on Biodiversity (UN CBD). Dryland research shows that the intentions and projects to combat desertification can lead to controversies between the conventions. Another serious deficiency is the considerable discrepancy between the interest to develop international environmental control structures and institutions, and simultaneously, little initiative to (re)introduce local, communal resources management control structures.

IV.2 Fighting soil degradation in a Sahelian context: problem awareness, constraints and management options

Schlecht, E.¹, Hülsebusch, Chr.², Graef, F.³

1 Institute for Animal Production in the Tropics and Subtropics (eset@uni-hohenheim.de), 2 Centre for Agriculture in the Tropics and Subtropics, 3Institute for Soil Science and Land Evaluation, University of Hohenheim, D-70593 Stuttgart, Germany

Rapid population growth forces farmers in South-western Niger to shorten fallow cycles and extend cultivated areas onto marginal land. Given the low fertility of Sahelian soils, these processes lead to accelerated nutrient mining on cropland. Semi-structured interviews with farmers in Chikal village in South-western Niger revealed that farmers are well aware of their fields' poor fertility and vulnerability to erosion. In order to alleviate these risks, restore soil fertility and prevent erosion, they presently apply crop residue mulch, branches of shrubs and animal manure. Quantitative assessment of mulching and manuring practices on representative farmers' fields, and the spatial coverage of these soil fertility management measures were evaluated within the 300km² village territory using aerial photography and GPS/GIS-based land-use mapping. Although farmers claimed mulching is practiced on > 80% of all fields, the amount of mulching material applied is inefficient for both erosion prevention and soil fertility restoration. Through the application of dry farmyard manure and corralling of livestock, considerably high amounts of dung are often deposited per unit of land, but overall spatial coverage is low. Mobile livestock herds contribute around 50% to cropland fertilisation. These herds usually belong to transhumant herders who drive their animals into the village territory to feed on crop residues. Taking into account all livestock sojourning in the territory, model calculations indicate that the manured surface could be doubled if all animals were rigorously corralled over night, although this area would still cover < 10% of the overall village field surface. It has been shown that farmyard manure application and corralling increase millet grain yields considerably. Concentrating manure on more productive fields would permit reconverting fields with low inherent soil fertility or high erosion risk into pastures. It is concluded that strategic corralling of livestock is an appropriate measure to secure food production and counteract land degradation in the Sahelian setting. In the light of the present results, the provision of pasturing opportunities for transhumant livestock within a village territory is one important step to achieving these goals.

IV.3 NiSOTER – a database for determining areas for soil and water conservation measures in degraded landscapes

Graef, F., Gaiser, T., Herrmann, L., Stahr, K., Frick, T.

University of Hohenheim, Frühwirthstr. 12, D-70599 Stuttgart, Germany.

The sandy soils of the West-African Sahelian zone are highly susceptible to wind and water erosion. Soil and nutrient losses at alarming rates occur particularly at the beginning of the rainy season when pastures and crops have not yet established so the erosive forces of the heavy convective storms meet the bare ground. The traditional erosion control practices, e.g. mulch application, pasture- and long-term fallow management do no longer keep pace with the increasing land use. Therefore various soil and water conservation (SWC) measures have been developed and are recommended by research and extension services. They include the stabilisation of slopes by stone lines, terraces, herbal stripes and various forms of agro-forestry measures, e.g. planting and management of trees, shrubs and windbreak hedges. Conservation tillage techniques such as minimum tillage, zero tillage and ridge cultivation are also considered highly beneficial. However, SWC measures need to be adapted to specific soil and landscape characteristics such as soil texture or terrain slope. Thus, knowledge about the spatial distribution of potential intervention areas, especially in the variable landscape of the Sahel, is an absolute necessity for target tailored extension. Hence, the NiSOTER (Niger SOil and TERrain) -database has been applied, to evaluate and indicate potential intervention areas suitable for specific SWC techniques.

IV.4 The economics of selected resource protection measures from the sub-humid to the arid regions of Benin-West Africa

Brüntrup, M.

*Independent Consultant, Vordere Schafstr. 11, 70599 Stuttgart,
(Michael.Bruentrup@t-online.de)*

In an ecologically, economically and socially highly diversified country such as Benin, very high efforts in adaptive research are necessary to develop adapted technologies. This issue is demonstrated in the light of experiences of the PGTRN (Programme de Gestion des Terroirs et des Ressources Naturelles) in promoting sustainable agricultural practices in six agro-ecological zones all over the country. On each site, a local NGO is responsible for executing participatory land use planning. Thereafter, one of their tasks is to assist villagers in selecting among a range of resource protecting activities in agriculture and forestry. The paper presents economic analysis for the most successful of these activities. Discounted net benefit increase and internal rates of return are the central parameters, supported by labour profiles and socio-economic and cultural bottleneck analysis. The influences of key variables such as prevailing crop rotations and opportunities for their intensification, crop and wood yields and prices, opportunity costs for labour or availability of bush/fallow land on innovation profitability are quantified in their effect on level and variability of profitability. As expected, the results show highly site and situation sensitive profitability of the innovations, and therefore in principle a high need for adaptive research and selective targeting of recommendations. But such research and extension is costly and difficult and carried out only partially. Some reasons for this are inherent to typical characteristics of resource conservation technologies: long periods before technologies can develop their full (positive and negative) impacts, long lags between costs and benefits; partial subsidies bias farmers' private cost-benefit-calculation. However, there are also institutional hindrances: In this paper it is argued that it is improbable that any of the institutions actually involved in this area can carry out useful adaptive research in an isolated manner. Each of them, and the individuals within them, have certain limitations and vested interests which make them quite ineffective in developing appropriate technologies. Consequences resulting from these handicaps are discussed. They include revised roles between research and extension, issues of cooperation between research and development institutions, research design and a plea for participatory technology development.

IV.5 Influence of different agricultural land use on soil erosion by water in Benin (West Africa)

Wolf, B., Junge, B., Skowronek, A.

*Universität Bonn, Institut für Bodenkunde, Nussallee 13, D- 53115
Bonn*

Theme of my Master Thesis (Diplomarbeit) is the analysis of effects of different cultivating methods on soil degradation in the savannas of central Benin. The thesis is part of the IMPETUS (Integratives Management-Projekt für einen Effizienten und Tragfähigen Umgang mit Süßwasser). The main objective of IMPETUS is to analyse the availability of scarce water in the West African countries, Marokko and Benin. The research of different aspects of the hydrologic cycle is given priority during the first part of the project. The investigation of different forms of erosion is undisputedly an essential operation of a soil scientist. High population density, rivalries in land use between farmers and livestock owners, desertification in northern parts of the country and cash crop cultivation lead to a strong increase in farming intensity. In the last five years farmers in the western part of central Benin have started to shift from traditional agriculture to cash crops like cotton, cashew, or maize. Cotton, which covers 60% of the agricultural land, is commonly cultivated three to four times in a row. Fallow, an integral part of traditional agriculture, is often left out in favour of cashew plantations. These changes induce a higher risk of soil erosion, which becomes particularly apparent in fields where crops like yam, cotton or corn are cultivated in rows and on mounds. During the field work, several research methods, like erosion parcels, sediment catchboxes and erosion measuring sticks have been used to measure the actual extent of soil degradation in fields with different cultures. First results have shown a strong correlation between erosion and maize cultivated in longitudinal direction to the slope. Similar results were found on measuring in a Yams field. In addition, all signs of erosion found in the area were registered and mapped. Except next to footpath, erosion is little. To gain information about type and distribution of soils, profiles were analysed in field and in laboratory. Furthermore an extensive farming survey was conducted in order to obtain information about cultivated crops and agricultural methods. This poster contribution shows different methods of measuring soil erosion in tropical environment, and some of their preliminary results.

IV.6 Determinants of Adoption of Soil and Water Conservation by Farmers in the Eastern Highlands of Ethiopia.

Bekele, W., Drake, L.

Swedish University of Agricultural Sciences, Department of Economics, Box 7013, 750 07 Uppsala, Sweden.

Multinomial logit analysis of survey data shows that farmers' ranking of soil erosion problem, vis-à-vis other major agricultural problems, is positively and significantly related to soil and water conservation (SWC) adoption. The ranking of the problem is itself significantly influenced by farmers' access to credit and the topography of plots. The relative wealth status of farm households is positively and significantly correlated with SWC adoption. This may imply that poorer farmers are more risk averse than wealthier farmers and/or that the opportunity cost of labor in rural areas is different for the relatively poorer and wealthier farmers. Participation of women in fieldwork activities, that are otherwise men responsibility, is positively related to conservation adoption. With the participation of women, the total available labor time increases for timely operation of activities, and the exposure of women to the problem of soil erosion improves the perception of the whole household about the problem. The results of the study also suggest that public support programs for initial investment in SWC influence farmers' adoption behavior positively. Such programs help to ease the competition for labor between food generating and conservation activities. Family size, which is a close proxy for the economically active household members, emerged to have negative correlation with SWC adoption. This may be explained by the relation between larger family size and higher demand for food in the household. As a result arise competition for labor between food generating activities and investment in soil conservation. The effect of land tenure policy on soil and water conservation behavior of farmers in the study area was found to be inconclusive. These results suggest the need for design and implementation of a wide range of policies and programs that will positively influence farmers' behavior towards the introduction of SWC measures in their agricultural practices.

IV.7 Impact of the human factor on the cassava cultivation under marginal conditions in the lakeshore area of northern Malawi

Borowka, R.¹, Hummel, H.E.²

1 Jahnstr. 65, D-71032 Böblingen, Germany. 2 Justus-Liebig-Universität, Ludwigstr. 21 B, D-35390 Giessen, Germany

In the framework of a technical cooperation project between Malawi and Germany on the control of the cassava mealybug, *Phenacoccus manihoti* Matile Ferrero (Hom.) and a thesis covering the same topic, we could gain an impression of the various factors determining the development of the cassava cultivation. These observations extended over a period of five years but do not claim to be representative. However they give an insight into some of the various factors prevailing in the cassava cultivation in Africa. These led to a partially unexpected finding which is briefly outlined here. Agricultural experiments in research stations tend to overestimate obtainable yields because of the exceptionally good experimental conditions. To avoid these biases, field experiments were carried out on farmers' fields in a site with marginal conditions in the northern lakeshore of Malawi. This unusual approach revealed various social conflicts. Included in the human factors under study were: the sharing of the burden of work between men and women, the tending of cattle, sheep and goats during the dry season and the readiness for adopting and adjusting new agricultural techniques to local conditions. The behaviour of the extension staff, as we could observe, plays a predominant role. Is the person responsible in the family for farming activities being approached? Although women in most cases are heavily engaged in farming activities, they are not considered as decision-maker or are forgotten in extension activities. The ability of the extension personnel to present new techniques with credibility and to adapt them to local conditions plays another decisive role. In spite of the scientific results collected over the study period, it became obvious that social factors could on long term play a much greater role in the cassava cultivation than scientific and technical knowledge.

IV.8 Satellite Monitoring of Short and Long Term Vegetation Dynamics in West-Africa: the Example of Benin

Kissiyar, O., Thamm, H.P., Menz, G.

*University Bonn, Dept. of Geography, Remote Sensing Research Group, Meckenheimer Allee 166, 53115 Bonn, Germany.
(o.kissiyar@rsg.uni-bonn.de)*

This contribution introduces the research into the possibilities of satellite remote sensing to monitor vegetation dynamics at various scales in West-Africa. The research is embedded in the IMPETUS project, an interdisciplinary research effort investigating two catchments on either side of the Sahara, in Morocco and Benin. The test area encompasses the whole of Benin, which has been confronted to fundamental changes in its demographical structure, agricultural systems and land cover during the past decade. This enables us to reflect the spatio-temporal response of the vegetation to changing environmental and anthropological factors. For a comprehensive monitoring approach three different data sets are selected : daily NOAA-AVHRR scenes are used for their high temporal resolution, Landsat TM is applied to provide enhanced spatial resolution (30m), and finally MODIS data was chosen in order to provide long term temporal continuity with NOAA-AVHRR whilst at the same time providing a higher spatial resolution. The methods chosen to characterise the evolution of the different vegetation types are twofold. First there is the derivation of various Vegetation Indices (VI's), as there are the Normalised Difference Vegetation Index (NDVI) and the Modified Soil Adjusted Vegetation Index 2 (MSAVI2). These are analysed over different time spans and various spatial extends. The second selected method is the derivation of biophysical parameters like there are Leaf Area Index (LAI), Evapotranspiration and Biomass. The estimation of Evapotranspiration and Biomass is supported by a Land Cover Classification. A qualitative assertion of the different methods used to derive the VI's and the biophysical parameters as well as the methods used to describe the vegetation dynamics will be undertaken. The challenges of this study are the production of a comprehensive image of the phenological cycles of the different vegetation types using VI's and the near-real-time derivation of the biophysical parameters Evapotranspiration and Biomass. This will help the understanding of the complex hydrological cycle under all it's aspects and results can be used in meteorological and hydrological models.

IV.9 Interactive simulation tools for action research on sustainable groundwater use in dry areas

Mueller, R.A.E.¹, Aw-Hassan, A.²

1 Department of Agricultural Economics, University at Kiel, 2 International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria.

The development of irrigated agriculture in the semi-arid regions of the world is critically constrained by scarce groundwater resources. Technological measures aimed at alleviating groundwater scarcity have limited success where water use is subject to the "tragedy of the commons". Such water-related tragedies are common in many developing countries where private rights to groundwater are inadequately defined or enforced. In the absence of private incentives to conserve groundwater group action or government regulation may be required if unsustainable groundwater use practices are to be avoided. However, given the intricate and dynamic interactions between groundwater availability, economic incentives for irrigators, crop and irrigation technologies, social norms governing water use, and government regulations and laws, designing appropriate rules and regulations governing groundwater use is difficult. In an interdisciplinary research effort dynamic simulation models of investments in wells and groundwater use for irrigated farming were developed. The models were based on farm data from Syria and were programmed using Stella software which provides a convenient interface for users unacquainted with dynamic systems simulation. The main purposes of the models were three: (1) to synthesize knowledge about farmers' decisions about the use of scarce groundwater for irrigating crops from wells; (2) to make this knowledge available to change agents (community leaders, extension agents, researchers, and policy makers) in a directly usable form; (3) to provide an simulated environment that allows important impacts of alternative rules and agricultural policies on sustainable groundwater use to be explored interactively. In our presentation we - explain the rationale for developing the simulation modeling; - describe and present the dynamic systems simulation models that have been developed using the Stella development tools; - report on our experience with the models as tools for thought and for structuring problem- focused dialogue among change agents.

IV.10 Erosion control and prediction in cassava based cropping systems in the southern Andean region of Colombia

Sonder, K.¹, Müller-Sämman, K.², Hilger, T.¹, Leihner, D.³

1 Universität Hohenheim, Institut für Pflanzenbau und Agrarökologie in den Tropen und Subtropen, Kirchnerstr.5, 70593 Stuttgart, Germany. (inst380@uni-hohenheim.de). 2 Institut für umweltgerechte Landwirtschaft (IfuL) Auf der Breite 7, 79379 Mülheim, Germany. 3 FAO, Research, Extension and Training Division (SDR), Viale delle Terme di Caracalla, 00100 Rome, Italy

The application and adaptation of the universal soil loss equation (USLE) to a tropical subhumid environment was the objective of a 12 year study at two sites in the Cauca department in the southern Andean region of Colombia. Specific emphasis was laid on the erosivity component of the USLE, the R-factor, as the energy-intensity term used was derived from measurements under temperate rainfall conditions, which is considered to be different as compared to tropical rainfall. Additionally, long-term fertility losses by erosion were monitored as characterizing soil erosion effects by amount of eroded soil alone may lead to misleading conclusions due to different soil types. Furthermore, seven cassava based cropping systems, among them two traditional ones, were evaluated for susceptibility to erosion and yield potential to give local farmers options to improve both erosion control and incomes. The applicability of the USLE's energy intensity relationship was confirmed for the research region's climate and high correlation factors were found between the R-Factor of the USLE and annual soil losses. A modified Fournier index was found to precisely estimate R-Factor values for areas where no rainfall intensity data are available. While erodibility of the soils was found to be between low and medium levels, the potential soil losses for the research region, as derived from permanent bare fallow plots, can be considered as very high due to the high erosivity of the climate. The seven treatments showed susceptibility towards erosion in the following order: sole continuous cassava; cassava based rotation with previous bush fallow >> cassava based rotation with legume strips; cassava traditional rotation > cassava based rotation with improved fallow management > cassava based rotation with minimum tillage; cassava based rotation with vetiver grass barriers. Both the vetiver grass barrier and the minimum tillage treatments reached equal or higher yields as compared to the sole continuous cassava treatment used by most farmers while reducing soil erosion between 93 and 98%. When comparing to the traditional rotation the minimum tillage treatment reached between 90 and 93% of the yield but reduced erosion by 67 to 81%.

IV.11 Digital Data Inventory for Natural Resource Management of Burkina Faso

Kappas, M., Schygulla, E.

University of Goettingen, Goldschmidtstr. 5, 37077 Goettingen, Germany, (mkappas@gwdg.de).

Digital data become more and more important for sustainable natural resource management. Particular with regard to developing countries many researchers, NGO's and other organisations are looking for basic digital informations about the respective country. Our project "Digital data Inventory Burkina Faso" provides digital informations in form of digital maps, tables or charts, that can be used for further information retrieval with Geographical Information Systems (GIS). Therefore all digital maps are based on an integrative reference system (Hammer-Aitoff Grid for Africa). The database is build up with CartaLinx Spatial Data Builder (Clark Labs, Clark University, Worcester, Massachusetts, USA). The Spatial Data Builder provides interfaces to different Desktop-GIS-Systems as IDRISI, ArcInfo, ArcView or MapInfo. Basic themes as geology, geomorphology, soils, vegetation, climate, river systems, infrastructure or population density are mapped for the entire country as well as for three regional areas (North, Central and South-West Burkina Faso). The single maps are well documented and represent an up-to-date database for natural resource management. The development of the entire database is in progress. The future trend is the integration of these existing multi-source and multi-scale data with remote sensing data in order to develop an information portal for sustainable landuse management.

Symposium V

Neglected Crops

V.1 Neglected Perennial Crops of Potential Food Value for Diversification and Sustaining Food Security

Subramaniam, B.

*Wealth of India Division, National Institute of Science
Communication, Dr. K. S. Krishnan Marg, New Delhi-110 012, India*

Perennial food crops have potential to meet the energy and nutrient requirements, and to alleviate the food crisis particularly in the tropical and subtropical regions. Tropics are known for their rich diversity of food crops but these have not been optimally exploited. Some of the neglected potential perennial crop species discussed for food diversification and sustaining food security are *Baccaurea ramiflora*, *Bouea oppositifolia*, *Broussonetia papyrifera*, *Buchanania lanzan*, *Cyphomandra betacea*, *Murraya koenigii*, *Madhuca longifolia*, *Artocarpus communis*, *A. lakoocha*, *Aisandra butyracea*, *Arenga saccharifera*, *Averrhoa carambola*, *A. bilimbi*, *Annona muricata*, *A. reticulata*, *Garcinia mangostana*, *G. indica*, *Feronia limonia*, *Phyllanthus acidus*, *Moringa oleifera*, *Spondias pinnata*, *Euphoria longan*, *Casimiroa edulis*, *Caryota urens*, *Terminalia catappa* and *Madhuca indica*. Some of the neglected drought-hardy fruit crops, which can provide food in arid and semi-arid regions, include *Carissa carandus*, *Grewia subinaequalis*, *Aegle marmelos*, *Emblica officinalis*, *Ceratonia siliqua*, *Adansonia digitata*, *Annona cherimola* and *Tamarindus indicus*. Most of these are multipurpose species, which can also provide feed for the livestock besides providing other products and services. Appropriate selection of perennial crops has been suggested so as to meet the food and nutrient requirements almost throughout the year. The selected perennial crops can be grown in mixed cropping systems for the advantages that they prevent building up of insect pests, and are able to extract and recycle nutrients from different zones of the soil. The paper also emphasizes the need for collection of wild gene pools as well as those in cultivation from different regions for genetic evaluation of their desirable traits, and for future crop improvement programmes. Bee keeping in the orchards needs to be promoted, as honeybees amongst insects are by far the most efficient and reliable pollinators. The salient botanical characters and ecology of the potential perennial crop species and the major nutrients present in the fruits as well as in other edible parts, and value added food products that could be developed from the crop produce for their use during the non-fruiting seasons have also been discussed.

V.2 Marketing and Production Systems of Indigenous Fruits of the Miombo Ecozone: A Case Study of *Uapaca kirkiana* and *Strychnos cocculoides* in Zimbabwe

Mithöfer, D.¹, Ramadhani, T.¹, Ayuk, E.T.²

1 Institut fuer Gartenbauoekonomie, Universitaet Hannover. 2 International Centre for Research in Agroforestry, Zimbabwe

In recent years the importance of indigenous fruits for nutrition, food security and cash income generation of farming households in rural Africa has been recognised. Various institutions including the International Centre for Research in Agroforestry (ICRAF) are working on the conservation and domestication of indigenous fruits. However, the current problems are lack of information on their economic value, their inadequate production and marketing systems. The objectives of this joint research are to provide baseline information on the economics of production and the existing marketing system as a back-up for the on-going research at ICRAF. In the production study the relative share of indigenous fruits in the cash and non-cash household income is compared to income from other sources. The marketing study examines the structure, conduct and performance of the existing market, its incentives and constraints. Following a priority setting exercise conducted by ICRAF in 1998, the top three species namely *Uapaca kirkiana*, *Strychnos cocculoides*, and *Parinari curatellifolia* were targeted for this research. Detailed formal and informal surveys were administered to farmers, policy makers, traders and consumers. Results show that fruits are an important element of food security as they are available at times, when very little other foodstuff is available. Cash income from indigenous fruits is lower than income from exotic fruits although the variability between households is high. On-farm investment, that is management of trees and planting activities, is relatively low compared to other production activities. Within the household, children consume more fruits than grown ups, cash income from the fruits is mostly used to cover household expenditure. The marketing system for indigenous fruits is less developed than for exotic fruits. Market outlets include village, roadside, district and central markets. Numerous actors of both gender are selling and buying fresh fruits. While consumer preference for indigenous fruits is high, a number of problems limit the market supply. Village by-laws arising from the traditional taboos restrict selling of the fruits, inadequate market facilities such as storage structures, and unreliable transport hamper conduct of the market.

V.3 Nutritive value and anti-oxidative capacity of *Euterpe oleracea* Mart. fruits from the Amazon

Lichtenthäler, R., Marx, F., Fabricius, H.

Universität Bonn, Institut für Lebensmittelwissenschaft und Lebensmittelchemie, Endenicher Allee 11-13, 53115 Bonn, Germany. (r.lichtenthaeler@uni-bonn.de)

Euterpe oleracea Mart., Arecaceae, is a palm widely distributed in northern South America growing from sea level to an altitude of about 3000 m, with its greatest occurrence and economic importance in the estuary floodplains of Pará State, Brazil. "Açaí", as it is known to the local inhabitants of the Amazon Basin, can reach a height of over 30 m and is multi-stemmed, sometimes having more than 45 slender trunks in different states of growth and fructification. Therefore, it is able to regenerate after cutting of several stems and has nowadays become the world's main source of palm hearts. Non-timber products of *E. oleracea* have currently only regional relevance. The most important of these goods are the spherical grape-sized fruits, that are green when young and ripen to a dark purple. They form bunches and are one-seeded, with the seed accounting for most of the size and being covered by thin but crude and stringy fibers under a small edible layer. The seeds are mostly utilized as pig food or, when rotted, for making a very rich potting soil. Fruits can be gathered all over the year with a main harvesting period from July to November and are primarily used to prepare a liquid by macerating their pulp. The resulting juice has the consistency of milkshake and is also called "Açaí" or "vinho de Açaí" (though it is not fermented or distilled). The taste of Açaí products is described as "unusual but savoury" and they are very popular throughout all socio-economic levels of the local population. The Açaí liquid has a very restricted shelf life and discolors rapidly, likely because of an oxidation of the fruit's pigments. It has been observed by local traders that the addition of halved Açaí seeds can delay the discoloration of the juice, but so far no research has been made to explain this phenomenon. So, besides analysis of the nutritional composition of Açaí fruits from different harvesting seasons (fat, fatty acids, sugars, acids), the anti-oxidative capacity of Açaí fruits and seeds was determined by Total Oxidant Scavenging Capacity (TOSC) assay. This test is a rather new approach to quantify the capability of single compounds or complex mixtures to neutralize the naturally occurring reactive oxygen species hydroxyl radical, peroxy radical and peroxy nitrite.

V.4 Studies on the micropropagation of *Pistacia mutica*

Ghoraishi, S.R.¹, Hornung, R.²

1 Imam Higher Education Centre, Daneshgah street, Enghelab avenue, Tehran, PoBox: 13145-498, IRAN. 2 Plant Biotechnology Laboratories (PBL), Imperial College at Wye, Wye, Ashford, Kent TN25 5AH, UK

This paper describes the micropropagation of *P. mutica*, which besides its use as rangeland tree serves as rootstock for *P. vera*. *P. mutica* can be propagated by seed, but seed germination in the natural habitat is usually below 10%. Seeds were collected in Iran and germinated under glasshouse conditions at Imperial College at Wye. Nodal segments from cuttings of glasshouse-grown plants were exposed to various tissue culture media, as there were Murashige and Skoog, Woody Plant Medium, Alderson, B5 and a combination of these. Significant differences between the media on shoot growth and proliferation were not revealed. Various cytokinins including BAP, Zeatin, and 2-ip were used for shoot growth and proliferation. BAP at concentrations between 5 and 20 µM was most efficient. In vitro rooting was assessed employing various auxins including IAA, IBA and NAA. Exposure to IBA at 100 µM for 5 days led to a significant improvement of root production. Environmental conditions on rooting and weaning were also studied. Incubation of explants in darkness did not affect root production, but shading of the basal part of explants increased rooting significantly. Reduction of culture vessel headspace humidity from 99% in the conventional culture system to 90% in an improved culture system increased rooting in *P. mutica* significantly. Culture in liquid medium did not result in any root production.

V.5 Promising new crops: success or failure?

Heller, J.

*University of Applied Sciences, Faculty of Horticulture and
Landscape Architecture, Von-Lade-Str. 1, D-65366 Geisenheim.
Present address: Am Rosengärtchen 12, D-65366 Geisenheim*

During the last decade, various developments have contributed to a change in perception of the importance of underutilized/neglected species at international level. These include: (1) agrobiodiversity in agricultural development (Convention on Biological Diversity and the International Technical Conference on PGR, Leipzig, 1996), (2) contribution of minor crops to food security and improved nutrition, (3) new market opportunities and (4) ecosystem stability and environmental changes. Within the context of the Global Forum on Agricultural Research there are ongoing discussions to explore ways and means to develop and strengthen research partnerships for underutilized and orphan commodities. At national level, especially in more developed countries, so-called new crop centres offer a communications network among new crop workers, whereas in developing countries research on minor crops is carried out by very few scientists. Frequently, the limited information available on many important and basic aspects of neglected and underutilized crops hinders their development and their sustainable conservation. Detailed information has been generated for 24 minor crops at the International Plant Genetic Resources Institute (IPGRI), Rome and two case studies will be presented here: Peach palm (*Bactris gasipaes*) and physic nut (*Jatropha curcas*). Peach palm for hearts of palm production was already highlighted in the NAS/NRC report and there has been a tremendous increase in cultivation area in Central and South American countries. Canned hearts of palm are exported to European countries and the USA. For the establishment of large scale plantations frequently virgin rainforest is cut down. Physic nut (*Jatropha curcas*), a multipurpose drought resistant shrub, is cultivated mainly for its oily seeds. Various development agencies have spent millions of R&D dollars on this crop. Projects concentrating on the energy aspect only have shown limited viability. Factors considered most critical for success or failure in developing new crops are: market potential, coordinated research activities, genetic improvement programmes and taking more into account the needs of the farmers.

V.6 The impact of forecast climate changes on the productivity, range, and sustainability of Coconut (*Cocos nucifera* L.).

Allen, E., Hornung R.

Plant Biotechnology Laboratories (PBL), Department of Agricultural Sciences, Faculty of Life Sciences, Imperial College at Wye, University of London, Wye, Ashford, Kent, TN25 5AH, UK.

The latest IPCC report forecasts that in the coming 50 years there will be highly significant changes in the global temperature regime, concentration of CO₂, and precipitation regimes over all areas of the world, with the most significant changes occurring over mid and high latitudes. The latest models indicate that there will be an effective increase in the size of the thermal zone of the tropics; which will enable tropical plant species to grow in areas previously beyond their physiological limits. Of particular concern for coconut production are the forecast increases in sea level and the impacts of this on the littoral growing zone that coconut so successfully exploits. This zone, in many areas of the world, is forecast to be inundated within the next 50 years, however the net impact of climate change may be positive, for global coconut production, as new areas are predicted to become suitable for coconut growth. It is clear that with the changes in environmental conditions, new ecotypes will be required. Mutation breeding has been identified as an efficient way of creating new cultivars, but it is suggested that existing non-domesticated ecotypes should be conserved for potential breeding programmes. This should be done in tandem with continuing work on clonal propagation of coconut. Moreover with the available effective forecasting and modelling of future environmental changes, there appears to be a clear opportunity to maintain coconut production in newly arising marginal areas by effective use of these technologies.

Acknowledging the significant amount of time and long-term funding required for the development of new cultivars, the combination of modelling applied to breeding programmes should allow a more strategically effective resource use in coconut producing areas. It is concluded that coconut will benefit from forecast climate changes, in terms of increasing the geographical range of coconut. This is in spite of the forecast problems associated with sea-level change.

V.7 A comparative assessment of the nutritional value of three varieties of African yambean (*Sphenostylis stenocarpa*) and of other legumes.

Azeke, M.A.¹, Betsche, T.¹, Büning-Pfaue, H.², Fretzoff, B.¹

1 Federal Centre for Cereal, Potato, and Lipid Research, Alliance Product and Nutrition Research, Institute for Biochemistry of Cereals and Potatoes, 32756 Detmold. 2 Institute for Food Science and Food Chemistry, University of Bonn Endenicher Allee 11-13, 53115 Bonn. (Betsche.BAGKF@t-online.de)

Interest is rising in developing countries in low-cost, relatively high-quality plant foods as replacements for or supplements to the expensive and frequently scarce animal foods. Despite their potential in this regard many legumes are, however, underutilized. African Yambean (AYB) is one example. Its underutilization is due to prolonged cooking time, presence of several components that interfere with digestion and can cause marked gastrointestinal distress. In this study we determined a range of nutrients and anti-nutrients in three varieties of AYB, namely AYB Black (AYBB), AYB Marble (AYBM) and AYB White (AYBW). The contents were compared with those in soybeans and Azuki beans. All of these legumes have high protein content ranging from 19.7-22.9% in AYB, 20.7% in Azuki and 35.4% in soybean. A lipid content of 19.9% was determined for soybean while much lower lipid contents (0.37-1.54%) were recorded for the other legumes. Total sugar ranged from 2.8-3.5% for AYB, 5.2% for soybean and 2.4% for Azuki bean. Dietary fibre ranged from 12.2-15.3% for AYB, 18.5% for soybean and 14.1% for Azuki while ash ranged from 2.6- 3.3% for AYB, 5.1% for soybean and 3.3% for Azuki. Trypsin inhibitor activity and cyanogenic glycosides were found to be highest in AYBW while soybean had the highest contents of oxalate, phytate, total oligosaccharides and saponin. Tannin content and alpha- amylase inhibitor activity were highest in AYBB. The predominant oligosaccharide in all legumes was found to be Stachyose except in soybean. Sucrose was predominant in soybean. Raffinose was low in all legumes. At present, treatments such as dehulling and cooking are recommended as means of reducing these anti-nutrients. Work on the fermentation is conducted to possibly provide a cheap and simple method to obtain an easily digestible vitamin-rich Yambean dish requiring less cooking time and energy.

V.8 Effect of fertilization on fiber production of Curauá (*Ananas lucidus* Miller) in the eastern Amazon Region of Brazil.

Berger, N., Kroschel, J.

University of Hohenheim (380), Institute of Plant Production and Agroecology in the Tropics and Subtropics, 70593 Stuttgart, Germany. (nberger@web.de)

Curauá (*Ananas lucidus* M.) is a monocotyledonous, perennial Bromeliaceae originating from the lower Amazon basin. It is a versatile crop which was already used by indigenous people in pre-Columbian times and is today still used in the manufacturing of ropes, fishing-nets or hammocks. Its fiber quality is higher than that of other natural fibers such as sisal (*Agave sisalana* P.) and a preferred biodegradable substitute for fiberglass in the manufacturing of fiber reinforced plastics. Among the species with potential for fiber production from the Brazilian Amazon basin, curauá has large potential for being used by the automotive and textile industries. However, the actual production values are excessively low to supply the industries with the required quantities of fiber, which is expected to be of more than 200 t per year. Low production levels and poor knowledge about the Curauá cultural needs demand for a deeper research in nutritional and climatic needs as well as for soil improvement measures. Therefore, field research was carried out between 1998 and 2001 to study the yield and growth performance of both curauá varieties (roxo and branco) as well as the impact of agronomic measures on its fiber quality in various cropping systems. Field trials with mineral fertilizer application were established close to Santarém in the Brazilian federal state of Pará. The application of high doses of mineral fertilizer in combination with a higher planting density resulted in a yield increase of up to 900% when compared to the average yield of local farmers and up to 306% when compared to the control treatment at the test site. In addition, production costs were reduced by almost 50%. In conclusion, the tested agronomic measures showed a high potential for improving the fiber yields of curauá and supplies the local small-scale farmers with a reliable cash crop.

V.9 Neglected crops from a different perspective

Heller, J.

*University of Applied Sciences, Faculty of Horticulture and
Landscape Architecture, Von-Lade-Str. 1, D-65366 Geisenheim.
Present address: Am Rosengärtchen 12, D-65366 Geisenheim*

Humanity relies on a diverse range of cultivated species; at least 6000 such species are used for a variety of purposes. Agricultural research has traditionally focused on major staples, while relatively little attention has been given to minor crops. The limited information available on many important and frequently basic aspects of minor crops (e.g. their genetic potential) hinders their development and their sustainable conservation. For this reason, the approach taken by a project coordinated at the International Plant Genetic Resources Institute (IPGRI), Rome was to research and publish relevant information on the genetic resources of a selected set of neglected crop species with appreciable development potential. Many terms are used in the literature to circumscribe the category of minor crops: e.g. neglected, underutilized, under exploited, orphan, humble and lost crops. In the project mentioned before, preference was given to the terms "neglected" and "underutilized". These terms are social rather than biological terms, they have different meanings and may cause confusion when used interchangeably. According to IPGRI, "neglected" refers to the lack of attention given to useful species by research and development institutions, whereas "underutilized" refers to the status and trends in the distribution and uses of a species by farmers and consumers. Accordingly, criteria can be identified that define the neglect and underutilization. Crops in the same commodity can be presented in a matrix, that combines neglect and underutilization, as minor crops usually fall into both categories. Conclusions can be drawn on the appropriateness of the size of collections in relation to the economic importance of the crop and vice versa. (As title for this poster the slightly modified title of the FAO book "Neglected crops: 1492 from a different perspective" was chosen. The aim of this book (published in 1994) is to analyse the present situation and the prospects for improving certain traditional crops that were more important before the discovery of America in 1492 and have now either been completely forgotten or play a marginal role.)

V.10 Diversification of cocoa multistrata agroforestry systems in southern Cameroon¹.

Sonwa, D.J.¹, Weise, S.F.¹, Nkongmeneck, A.B.², Tchatat, M.³, Adesina, A.A.⁴, Ndoye, O.⁵

1. IITA, P.O. Box. 2008, Messa, Yaoundé, Cameroon. (*iita-humid@cgiar.org*) 2 Department of Plant Biology, University of Yaoundé I, P.O. Box 812 Yaoundé. 3 Institut de recherche Agricole pour le Développement (IRAD), B.P. 2067 Yaoundé. 4 The Rockefeller Foundation, Agricultural Sciences Division, 420 Fifth Avenue, New York, NY 10018-2702, USA. 5 Center for International Forestry Research (CIFOR), BP 2008, Messa, Yaoundé.

Faced with declines in profits and labor productivity of cocoa in the past decade, the majority of smallholder cocoa farmers in southern Cameroon are increasingly diversifying their income generation and food production activities. Farmers are enriching their cocoa plantations by increasingly integrating forest species, fruit trees, and annuals. This study characterizes the vegetation structure and composition of this evolving agroforestry system and identifies the species preferentially planted by farmers within the Forest Margins Benchmark in southern Cameroon. The cocoa plantations around Yaoundé (an area with a relatively high population density and related land scarcity) contain nearly twice as many trees that provide consumable products but only half as many timber species as plantations in the sparsely populated southern sections of the benchmark area. Of the five most important species used, *Dacryodes edulis*, *Persea americana*, *Mangifera indica*, *Citrus sinensis*, and *Citrus reticula*, only the first is indigenous. The five most common non-fruit tree species used are *Terminalia superba*, *Triplochiton scleroxylon*, *Chlorophora excelsa*, *Ceiba pentandra*, and *Ficus mucoso*. The first three are timber of high value i.e. they are regularly exported. The management of trees in cocoa agroforests is now seen as an opportunity to earn cash, minimise the risk associated with the fluctuation of cocoa prices, and provide shade to the cocoa stand.

V.11 Effects of harvesting methods and deflowering on yield of leafy vegetables (*Amaranthus* and *Solanum* spp.) under drought stress.

Diwani, T., Janssens, M.J.

Institut für Obst- und Gemüsebau, Universität, Auf dem Hügel 6, D-53121 Bonn., (thuweba@wildmail.com)

Traditional leafy vegetables are an important source of food for many African families. They also contribute substantially to the income of small scale farmers (many of whom are women). *Amaranthus cruentus*, *Solanum aethiopicum* ssp. *kumba* and *S. nigrum* are some of the most widely grown leafy vegetables in Africa. Water deficiency is one of the limiting factors in leafy vegetable production leading to significant reduction in leaf yield. Most farmers cannot afford irrigation and must therefore resort to cultural measures (e.g. harvesting methods and deflowering) to minimise negative effects of drought. A pot experiment was conducted in an unclimatised greenhouse at Marhof Research Station, Wesseling, in Germany, between July and December, 2000. Five cultivars of traditional leafy vegetables were subjected to three harvesting methods (single harvest, ratooning and defoliation), deflowering and three levels of drought stress (30, 50 and 100% field capacity -FC). Growth and yield parameters were examined. Cultivars differed significantly in dry matter accumulation. The highest leaf yield was recorded in *S. nigrum* at 100% FC. *S. nigrum* also had the highest reduction in leaf dry matter due to drought stress at 30% FC. *S. aethiopicum* ssp. *kumba* showed the lowest reduction in dry matter due to drought. Single harvest and multiple defoliation resulted in higher leaf yield than ratooning. Multiple harvests reduced the effects of drought on leaf dry matter accumulation. Deflowering generally increased leaf yield under conditions without drought stress. Thus, defoliation may be the favoured harvesting method in drought prone areas, while deflowering may be recommended in irrigated vegetables. Additional research is needed on a wider range of cultivars to validate these findings under field conditions.

Symposium VI

Abiotic Stresses and Soil Management

VI.1 Models of physiological stresses for agricultural systems

Dingkuhn, M.

Agronomy Program, Cirad-amis, TA 40/01 Avenue Agropolis, 34398 Montpellier Cedex 5, France, (dingkuhn@cirad.fr)

Modelling of agricultural systems must incorporate physiological stresses. To serve as decision aid, models should be quantitative and robust. Simplified models simulating stresses, suited to the relevant scale and available data, are embedded in the representation of larger production or cropping systems. The systems' boundaries have to be carefully defined according the objectives and relevant factors. The ideal model is minimalist, unless it is to serve multiple purposes. Two "minimalist" models for the Sahel are presented. RIDEV (WARDA, Senegal) simulates heat- and chilling-induced spikelet sterility of irrigated rice depending on site, date and variety, permitting risk analyses to optimise cropping calendars. The model simulates crop phenology driven by microclimate and photoperiod, and predicts thermal damage to reproductive organs occurring during critical development stages. Risks of crop failure are estimated using historical climate. Simulated crop duration can also be used to assess water demand for irrigation. RIDEV is used in agronomic research, extension and crop improvement. SARRA (CIRAD, France) simulates drought risks for dryland cereals. The daily water balance uses atmospheric demand (ETP), a dynamic crop coefficient (Kc) enabling calculation of maximal crop ET ($ETM = Kc * ETP$), and a dynamic root front (limited by wetting front, time and genotype) that sets the size of the soil water reservoir. The fraction of transpirable soil water limits transpiration using the Eagleman equation, and the ratio of real transpiration over ETM serves as a stress index. Integrated over the season, this index provides for a yield index that can be calibrated with field data. SARRA is widely used for zoning exercises and, in conjunction with Meteosat data, for regional yield forecasts (Agrhymet, Niamey). Simple stress models such as RIDEV and SARRA are surprisingly robust but require complementary information if used as decision aids. Consequently, models have been devised that integrate many crops, agronomic options and stresses (ex: DSSAT, APSIM, STICS). Such encyclopaedic, multi-purpose tools rarely serve their declared purpose as decision aid systems but stimulate research by bringing scientists together. The generalised use of biophysical models in extension, research and education, however, remains the exception, despite the fact that we need them as badly as the pilot needs his instrument panel and the administrator his spreadsheet – as an extension to our brain's cognitive and computing capacities. Typically, not the complexity of the problem but that of programming environments deters potential users. This should be improved to enable researchers to routinely apply the "what-if" test to their hypotheses. A RIDEV or SARRA can stand at the end of many a thesis and help bridging the gap between stress physiology and agricultural reality.

VI.2 Screening for contrasting leguminous litter quality in relation to different patterns of decomposition and N mineralization or immobilization.

Cattanio, J. H.¹, Kühne R. F.¹, Vlek, P.L.G.²

1 Institute for Crop Production in the Tropics, University of Göttingen, Grisbachstr. 6, 37077 Göttingen, Germany. (jcattan1@gwdg.de.) 2 Center for Development Research - ZEF, Walter Flex Str. 3, 53113 Bonn, Germany

In Amazon "slashing and burning" agriculture converted large areas of primary forest to temporarily used agricultural land. Thus, the fallow vegetation plays an important role to maintain or restore soil productivity. The intensification of land use has drastically reduced the fallow period, and the soil quality has to be restored in shorter time. The new technique proposed for Amazonian agriculture includes rotational fallow systems with planted leguminous trees, and replacing burning by biomass mulching to protect the soil and to release organically bound nutrients. If burning is to be abandoned, then the synchronization of nutrient release from organic material and nutrient uptake by plants will be the core problem in applied soil biology research. The objective of this work was to screen mulching systems for contrasting litter quality and quantity in relation to different patterns of organic matter (OM) decomposition and net N-losses or -immobilization. The field research was conducted near Igarapé-Açú, Northeast of Pará in the Amazon region of Brazil. Decomposition and N release were studied using fine-mesh litter bags with contrasting leguminous litter quality. The samples from each treatment were analyzed for total C and N; lignin, cellulose and soluble polyphenolics content. The decomposition rate constant varied with species and time. Ash free dry matter loss from the litter bag material after 96 days was 30.1 % (*A. angustissima*), 32.7 % (*S. paniculatum*), 33.9 % (*I. edulis* and Fallow vegetation), 45.2 % (*A. mangium*) and 63.6 % (*C. racemosa*). Nitrogen release patterns from leguminous plant residues were differed from patterns of corresponding dry matter losses. All treatments showed immobilization of N and a significant negative correlation with phenol, C:N ratio, lignin+phenol:N ratios, and phenol:phosphorus ratios with nitrogen content in litter bag material. These results show that the *slash-and-mulch* systems need to be improved in term of synchronization of nutrient release from organic material and nutrient uptake by crops.

VI.3 Uptake and distribution of sodium and potassium in salt-stressed irrigated rice in relation to development stage and climatic conditions

Asch, F.¹, Dingkuhn, M.² and Dörffling, K.³

1 Uni Bonn, ACI, Karlrobert-Kreiten-Str. 13, 53115 Bonn, (fa@uni-bonn.de). 2 CIRAD-AMIS, P. B. 5035, 34032 Mountpelier. 3 Uni Hamburg, Institut für Allg. Botanik Ohnhorststr. 18, 22609 Hamburg.

Salinity is a major constraint to irrigated rice production, particularly in semi-arid and arid climates. Irrigated rice is a well suited crop to controlling and even decreasing soil salinity, but rice is a salt-susceptible crop and yield losses due to salinity can be substantial. Furthermore, the severity of salinity effects is influenced by climatic conditions, such as air humidity. In this study, uptake and distribution of sodium and potassium were followed over two climatically different seasons in a field trial in Senegal, West Africa in three contrasting rice cultivars grown with and without floodwater salinity. The cultivars were: IR 31785-58-1-2-3-3 (IR 31785) highly susceptible, improved, semi-dwarf indica, I Kong Pao (IKP) tolerant, traditional japonica, and IR 4630-22-2 (IR 4630), tolerant, improved, semi-dwarf, indica. The ion concentrations of all above ground plant organs, dead leaves, and roots were determined from weekly samplings. Clear differences between seasons and within seasons among cultivars were found in ion uptake and distribution. In general highest sodium and potassium concentrations were found in the leaf sheaths and stem bases. Leaf sodium accumulation increased with leaf age, whereas leaf potassium concentrations decreased. Dry season conditions increased the uptake of sodium, whereas wet season conditions increased the uptake of potassium. Leaf sodium accumulation in susceptible IR 31785 was closely linked to relative humidity, but not influenced by relative humidity in the tolerant cultivars. Potassium uptake and accumulation was not related to relative humidity. Cultivars showed large differences in the amount of both ions taken up to the plant as well as their distribution within the plant according to their degree of resistance and their resistance strategies. Several mechanisms were identified that influence sodium and potassium uptake and distribution, such as root selectivity, stem retention, stomatal reactions to humidity and leaf tissue thresholds. Implications for plant breeding, selection tools and crop modeling are discussed.

VI.4 Transpiration and water use efficiency of different tropical crop species

Burkhardt, J.¹, Dagbenonbakin, G.¹, Goldbach, H.E.¹, Schroth, G.²

1 Institute of Agricultural Chemistry, University of Bonn, Karlrobert-Kreiten-Str. 13, 53115 Bonn, Germany. 2 National Institute for Research in the Amazon (INPA), C.P. 478, 69011-970 Manaus-AM, Brazil

Due to reduced water availability and climate change, the use of water preserving crops may be an essential point in agriculture in the forthcoming years. Even in many very humid environments like central Amazonia there are periods of water stress for the plants. The transpiration of higher plants depends on the environmental conditions as well as on intrinsic adaptations and limitations of the plant (species). As a consequence, the possibility of plant cultivation in non-irrigated crop systems depends on the knowledge of adapted species and cultivars and suitable management strategies. Transpiration is actively controlled by stomatal regulation, which represents a complex physiological feedback system. In addition to water availability and atmospheric demand, hydraulic constrictions of roots or shoots may also limit plant transpiration. It is also known that transpiration and water use efficiency can be affected by different nutrition and management of crop systems. This is the background for measurements of water use by tropical crop species carried out as part of the IMPETUS project in the subhumid zone of northern Benin. The water use efficiency is studied, as affected by plant nutrition for various crops (yams, groundnut, maize, sorghum, cotton), focusing especially on the use of organic fertilizers, which is not a very common practice in the area yet. Measurements of stable carbon isotopes can generally give good indications of the long-term water use efficiency of plants. However, a suitable experimental set-up has to be provided, due to a large variety of parameters influencing carbon isotope discrimination. First results of the project study are given and water relations of the different crops are discussed.

VI.5 Mulching and nitrogen fertilization of shallot in Ethiopia

Woldetsadik, K., Gertsson, U., Ascard, J.

Department of Crop Science, The Swedish University of University of Agricultural Sciences, P.O. Box 44, SE-230 53 Alnarp, Sweden

Two field experiments were conducted with shallot (*Allium cepa* var *ascalonicum* Baker) to evaluate growth and yield response to mulching and nitrogen fertilization under rain-fed semi-arid climate of eastern Ethiopia during the short and main rainy seasons of 1999. The treatments included wheat straw, clear and black plastic mulches and an unmulched control, each with nitrogen rates of 0, 75 or 150 kg ha⁻¹. Straw and black plastic mulches increased soil moisture while clear plastic reduced it considerably. Weed control was highest with black and clear plastics in the short season and with black plastic and straw mulch in the main season. Both plastic mulches elevated soil temperature, especially clear plastic, which also caused most leaf tip burn. Yield increased nearly three-fold with the black plastic mulch in the short season and by one fourth in the main season compared to the bare ground. The straw mulch increased yield during the short season, but slightly reduced yield in the main season. The growth and yield of shallot were related to the weed control and soil moisture conservation efficiency of the mulches. Mulching did not alter the dry matter content of the bulbs. The total soluble solids of the bulbs were slightly reduced by mulching only in the main season. Nitrogen fertilizer increased leaf numbers and height while reducing bulb number, but did not significantly affect bulb weight, yield, leaf tip burn, weed abundance, soil moisture or soil temperature. Results of this study indicate that the effect of mulching was not sufficiently great to allow the crop to utilise nitrogen fertilizer under rain-fed conditions, although the soil was naturally low in fertility. Supplementary irrigation or early planting with better crop protection practices is suggested. The costs and environmental effects of using plastic for production of shallots and other vegetables under rain-fed conditions must also be considered before recommending it generally for large-scale use.

VI.6 Detection of Water Stress in Field Grown Maize by Using Spectral Vegetation Index

Bahrn, A.¹, Jensen, C. R.², Mogensen, V.O.²

1 Fakultas Pertanian, Universitas Haluoleo, Kampus Bumi Tridharma, Anduonuhu, kendari 93232, Indonesia. 2 The Royal Veterinary and Agricultural University, Department of Agricultural Sciences, Laboratory for Agrohydrology and Bioclimatology, Agrovej 10, DK-2630 Taastrup, Denmark

As water availability is getting more limited, tools are needed to easily make timely decision for initiation of irrigation. Therefore, we investigated if the reflectance vegetation index (RVI) from remote sensing of the crop during soil drying compared with a fully watered plot as a reference could be used as such a tool for detection of water stress. RVI was measured when green crop area index (CAI) increased from 1 to 4 during the early vegetative stage of growth. RVI was calculated from incoming (PAR_i) and reflected (PAR_c) photosynthetically active radiation and from incoming (N_{li}) and reflected (N_{lc}) near infrared radiation using the equation $RVI = (N_{lc}/N_{li})/(PAR_c/PAR_i)$. The effect of soil drying on leaf expansion, biomass accumulation, abscisic acid (ABA) in xylem sap, leaf water potential and leaf nitrogen content were followed as drought indicators in maize (*Zea mays* L.) grown in lysimeters in the field. Five to seven days after the onset of soil drying RVI started to decrease in droughted plants when xylem [ABA] increased. Leaf nitrogen content of upper leaves decreased five to ten days after the onset of soil drying. Not until 20 days after onset of soil drying, midday leaf water potential (R_{leaf}) of droughted plants were significantly decreased below (R_{leaf}) of fully irrigated plants when RASW was 20 %. RVI was highly correlated with green crop index ($R^2 = 0.82$) and biomass accumulation ($R^2 = 0.86$). We suggest that measurements of RVI of droughted field plants related to RVI of fully irrigated reference plants within the same field can be used as early warning system for irrigation during the early vegetative growth stages in maize.

VI.7 C and N availability limit microbial P in tropical low-P soils

Bünemann, E.¹, Oberson, A.¹, Smithson, P.C.², Jama, B.², Frossard, E.¹

1 Group of plant nutrition, ETH Zurich, Eschikon 33, CH-8315 Lindau, Switzerland. 2 International Centre for Research in Agroforestry (ICRAF), P.O. Box 30677 Nairobi, Kenya

On P-limited soils in Western Kenya, introducing 6-8 months of fallow with a legume such as *Crotalaria grahamiana* into small farmers' maize monocropping is able to double annual maize yields. Processes behind this increase in soil fertility are not well understood. We investigated how inorganic, organic and microbial P are affected by maize-fallow rotations as compared to maize monocropping and by P fertilization. In addition, we clarified some nutritional limitations of microbial P. Topsoil contents of organic and microbial P were significantly higher in maize-fallow rotations than in the maize monocropping system without being affected by P fertilization, while levels of extractable inorganic P were affected by P fertilization only. In spite of very low levels of available P, the microbial biomass was able to rapidly take up P when supplied with C and N in a lab incubation but the increase in microbial P was much greater for glucose than for cellulose additions. Carbon quality therefore appears to have a distinct influence on the extent of P immobilization. In the field situation, fallow growth responded poorly to P fertilization and microbial P did not differ between -P/+P plots of the same cropping system. A year after the last incorporation of fallow biomass, microbial P correlated well with the amounts of above-ground plant C incorporated into the soil. In conclusion, analysis of field soils as well as substrate additions show that in this tropical low-P soil, microbial P is limited by C and N rather than P availability and could thus be of great importance as a mediator of P transformations.

VI.8 Organic amendment, decomposition, nutrient release and nutrient uptake by millet crop under a traditional land rehabilitation technique in the Sahel

Dougbedji, F., Martius, Chr., Vlek, P.L.G.

*Center for Development Research (ZEF), Walter-Flex-Strasse 3,
53113 Bonn, Germany (fatondji@uni-bonn.de)*

In the Sahelian zone, due to the increasing population pressure and the resulting increase in cropped land area, fertility restoration through the fallow system is becoming increasingly inefficient. To cope with this problem, some farmers have to rely on degraded bare lands for agricultural production. The traditional land rehabilitation technique zai is one of the potential technologies to help address the problem. The zai technique consists of digging small pits of 20-30 cm diameter and 10-20 cm deep into degraded soils, often hardpans. At the bottom of the pits farmers place about 2 handful of organic material (animal dung or crop residue). They plant in the pits at the rain set. Research conducted so far on the technology showed that it enhances crop productivity on degraded lands. Experiments were conducted on station during off-season 1999 and 2000 at ICRISAT research station, and on-farm during the 1999 and 2000 rainy seasons at two sites in Niger to help improve the effectiveness of the zai technology by understanding the process of nutrient release, availability and uptake by plant in the zai. In these experiments, combinations of different quality and quantities of amendment were studied as well as the effectiveness of the Zai technique compared to surface application of organic amendment with regard to nutrient and water use. Our results indicate that the zai technique is an efficient way to enhance productivity of pearl millet in the marginal areas of the Sahel. Additional 500 kg ha⁻¹ of millet grain yield was obtained with the zai compared to surface application of cattle manure. The results also show that, on highly degraded soils, good-quality organic amendment is essential for grain production with the zai technique. Only 20 kg ha⁻¹ grain yield could be obtained with non-amended pits, 180 kg ha⁻¹ with crop residue and 1200 kg ha⁻¹ with manure. The zai technique is simple but requires hard work, however as the pits are dug during the off-season when farmers do not have other field activities, this is less of a constraint. The zai technique offers good potential to combat desertification.

VI.9 Interrelationships between microbial and soil properties in young volcanic ash soils of Nicaragua

Joergensen, R.G., Castillo, X.

Department of Soil Biology, University of Kassel, Nordbahnhofstr. 1a, 37213 Witzenhausen, Germany

The activity and biomass of soil microorganisms were measured in soils from 25 different arable sites in the Pacific region of Nicaragua with the objective of elucidating their interrelationship with soil textural and soil chemical properties. All soils developed from recent volcanic deposits but differ in their particle size distribution. Short-term phosphorus fixation capacity varied widely and was on average 11% of added P. In contrast, long-term P fixation capacity varied within a small range of around 55%. Mean basal respiration was 8.6 $\mu\text{g CO}_2\text{-C d}^{-1} \text{g}^{-1}$ soil, average contents of biomass C, biomass P, and ergosterol as an indicator of fungal biomass were 116, 1.95, and 0.34 $\mu\text{g g}^{-1}$ soil, respectively. They were all, except biomass P, were significantly lower in the sandy than in the loamy soils. The mean biomass C-to-soil C ratio was 0.69%, the mean metabolic quotient 95 $\text{mg CO}_2\text{-C d}^{-1} \text{g}^{-1}$ biomass C, the mean ergosterol-to-biomass C ratio 0.31% and the mean biomass C-to-P ratio 107. The very low ergosterol-to-biomass C ratio indicates that fungi contribute only a relatively small percentage to the microbial biomass. The biomass C-to-P ratio exceeded considerably the soil C-to-total P ratio. Metabolic quotient $q\text{CO}_2$ and ergosterol-to-biomass C were both negatively correlated with biomass C-to-soil C ratio and clay content, indicating positive correlations between $q\text{CO}_2$ and ergosterol-to-biomass C ratio and between biomass C-to-soil C ratio and clay content. Key problems of soil fertility and soil quality in Nicaragua are low availability of soil organic matter and phosphorus to soil microorganisms, which are magnified by a low percentage of fungi, probably reducing the ability of soil to provide nutrients for plant growth.

VI.10 Tropical soils in the savanna of Benin/West Africa

Junge, B., Skowronek, A.

*Universität Bonn, Institut für Bodenkunde, Nussallee 13, D-53115
Bonn, Germany (junge@boden.uni-bonn.de)*

The project IMPETUS (An integrates approach to the efficient management of scarce water resources in West Africa) started its work in May 2000 to research the natural availability of freshwater in Benin. During the first period scientists of different disciplines examine several aspects of the hydrologic cycle. The soil scientist researches construction, quality and distribution of soil units as well as soil degradation by water in view of the loss of water reservoir. The soil units of the research area near Dogué consists of different geological layer. Sandy sediments, hillwash, dominate in the upper part of the regolith whereas basal gravel exists in deeper parts (FÖLSTER 1983). In the course of time different soil units are developed out of this material: in higher parts of the landscape Plinthic Lixisols (O.R.S.T.O.M.: Sols ferrugineux tropicaux lessivés, USA : Plinthustalfs, BRD: Parabraunderden) und Eutric Cambisols (O.R.S.T.O.M.: Sols bruns, USA: Haplustepts, BRD: Braunerden) dominate. Lithic Leptosols (O.R.S.T.O.M.: Sols peu évolués d'origine climatique, USA : Ustarents, BRD: Ranker) can be found on the surface of inselbergs and Gleysols (O.R.S.T.O.M.: Sols hydromorphes minéraux ou peu humifières, USA : Psammaquents, BRD: Gleye) are situated in vallies which are influenced by groundwater. The soils are week acid, without carbonate and characterized by small amounts of organic material. The cation exchange capacity is very low whereas the base saturation reaches high percentages in general. The poster gives an overview about the soil units found in the savanna near Dogué. Some characteristic chemical and physical parameters and the classification following the instructions of World Reference Base (WRB), Food and Agricultural Organisation (FAO- Unesco), Soil Taxonomy (USA), French and German Soil Systematic.

VI.11 Options for suppressing weeds in tropical, direct-seeded, flooded rice: method and rate of seeding

Le, P.T., Denich, M., Vlek, P.L.G.

Center for Development Research, University of Bonn, Walter-Flex-Str. 3, 53113 Bonn, Germany

High weed pressure is one of the most challenges facing farmers growing direct-seeded, flooded rice in the tropics. Many farmers have depended on the application of herbicides as their main weed control method. However, the repeated use of a limited number of herbicides has led to the development of resistant weed species. The extensive use of herbicides, on the other hand, has negatively affected the environment and come under increased criticism. Improvement of seeding method and seeding rate might be an alternative to minimize weed competition in tropical, direct-seeded, flooded rice. Two experiments with split-split plot design were conducted in the 1998 wet and 1999 dry seasons in Maligaya, Nueva Ecija, the Philippines. Seeding methods including conventional broadcast seeding, modified broadcast seeding and drum seeding with north-south and east-west row orientations were assigned to the main plots; seeding rates at 40, 80 and 160 kg seeds ha⁻¹ were assigned to the subplot; and the sub-subplots were with and without weed controls. The results from both seasons showed that weed growth parameters responded significantly to different seeding methods and seeding rates. The correlation between weed biomass and rice grain yield reduction caused by weeds was found highly positive. Drum seeding with east-west row orientation had less yield loss due to weeds compared to other seeding methods. The advantages of drum seeding with east-west row orientation were attributed by higher numbers of panicle m⁻² as well as of spikelets panicle⁻¹. The seeding rate of 160 kg seeds ha⁻¹ could also minimize yield loss caused by weeds, and this was primarily due to high number of panicle m⁻². This study suggests that suitable cultural practices could be used instead of herbicide in order to suppress weeds in direct-seeded, flooded rice in the tropics.

VI.12 Optimisation of the Biological Nitrogen Fixation in semi-arid tropical agroecosystems by the Capsule-Lyophilisate-Technique

Russok, Chr.¹, Hornetz B.²

1 *Agrikulturchemisches Institut, Bonn.* 2 *Geographisches Institut, Universität Trier*

Biological nitrogen fixation as a sustainable nutrient source with regard to the optimisation of soil quality and sustainable agriculture gets a decisive importance for resource poor farmers in the marginal areas of the tropics. Traditional carrier techniques of inoculation with host-specific rhizobia have turned out to be quite ineffective due to the desiccation of the carrier material resulting in poor nodulation and fixation rates. Effectiveness of the traditional method of inoculating legume seeds using carrier material which incorporates host specific rhizobia is low due to desiccation, pesticides and some soil parameters such as low pH. Farmers also find the method cumbersome because the adhesive material applied to help the carrier material stick on seeds, also makes the carrier stick on their hands, thus making it difficult to easily separate the number of seeds required per hole. Therefore, a new capsule-lyophilisate-technique was developed which is able to withstand the harsh environmental conditions of the tropical drylands. Bioassays were performed with *Phaseolus vulgaris* and *Vigna radiata* in the climatological laboratory of the University of Trier; plants and soils were inoculated with the different techniques and different intensities of rhizobial populations. Biometrical as well as soil analytical measurements, acetylene reduction assay and microscopical observations showed that: a) the new capsule-lyophilisate-technique is more effective than the carrier approach in terms of plant development, N_{min} production, nodulation, C₂H₂ reduction; b) plants inoculated directly with rhizobial material were more vigorous in growth than the others. This is an indication that from an economic point of view, the cheaper indirect inoculation approach could be considered as an alternative.

VI.13 Stress responses and abscisic acid root signals in relation to drought stress intensity in three upland rice cultivars.

Andreassen, A.¹, Asch, F.², Jensen, C.R.¹

1 The Royal Veterinary and Agricultural University, Dept. for Agricultural Sciences, Agrohydrology and Bioclimatology, Agrovej 10, 2630 Taastrup, Denmark. (anda@kvl.dk). 2 University of Bonn, Institute for Agricultural Chemistry, Bonn.

Abscisic acid (ABA) regulates stomatal aperture and, therefore, plays a major role in the conservation of water and ultimately in water use efficiency (WUE). Additionally, drought-induced ABA root signals are known to reduce leaf elongation rate, which in turn reduces transpiring leaf area. Therefore, xylem ABA is an interesting parameter in drought responses in new rice types. Recent breeding research has resulted in new promising progenies from a cross between a high yielding *Oryza sativa japonica* and a drought resistant, weed competitive *O. glaberrima*. The interspecific hybrid and the parent cultivars were subjected to drought stress during late vegetative/early reproductive phase. Two different growing systems imposed either shock-like severe drought or a more slowly persistent drought. Rice was grown in small pots containing about 400g of soil which dried out to permanent wilting in about 50 hours in a climate chamber, or in pots containing about 15 kg of soil, which dried-out to permanent wilting in 10 days in a greenhouse. Physiological and morphological responses were measured daily during the drought event in the two set-ups. Root xylem sap was collected with a pressure bomb and analysed for ABA-content. Additionally leaf rolling score, photosynthesis, stomatal resistance, effective leaf area, and leaf elongation rate were measured. The intensity of the drought stress had a strong influence on physiological responses of the different rice cultivars. In general, fast soil drying induced direct responses of xylem ABA, stomatal resistance and root water potential, whereas slow soil drying triggered different responses depending on the cultivar. Results from shock-like severe drought show that the progeny produced about twice as much ABA than the parental cultivars and that both morphological and physiological reactions were induced at higher soil moisture levels. Both results suggest that the progeny has a better water conservation ability and probably higher WUE than both parental species. This was confirmed by results from experiments with less rapid, persistent drought (though less clear) where the progeny utilized soil water to a greater extent than the parental species and thereby indicated a higher WUE. *O. glaberrima* showed the greatest ability of adaptation to adverse conditions. Implications for drought hardening and internal plant signaling are discussed.

VI.14 Heritability of Traits Related to Dehydration-Avoidance and Their Interrelations in Tepary Bean

Mohamed, F.M., Keutgen, N., Tawfik, A.A., Noga, G.

Institut für Obstbau und Gemüsebau der Universität Bonn, Auf dem Hügel 6, D-53121, Bonn, Germany. (mofouad@yahoo.com).

Tepary bean (*Phaseolus acutifolius* A. Gray) is a potential legume for human diet which is well adapted to arid environments. It also could be used as germplasm to improve common bean (*Phaseolus vulgaris* L.) through interspecific breeding. Mechanisms underlying the ability of tepary bean (TB) to cope with water deficit have been defined. However, information is needed on the magnitude of the environmental and the genetic component of the variation in TB germplasm population for the traits related to its drought resistance and their interrelations is needed. This would enable conducting an efficient screening of potential lines and to development more drought resistant lines, and to use them to improve common bean. In the present study, seven tepary bean (TP) lines (NE#5, NE#6, NE#7, NE#8A, NE#15, NE#19 and L-242-45) were used. The following root and shoot characteristics were studied: depth of the deepest root, root growth pattern, dry weight of roots, leaf and stem, R/S ratio, leaf area and number, relative water content, specific leaf mass, stomata conductance and transpiration rate. Great variability was observed among the tepary lines for all studied parameters. Combination of potential leaf and root genotypes was shown to be the most effective strategy for TP to cope with drought stress. Nevertheless, they are not strongly correlated with each other. Heritability estimates indicated that a considerable amount of genetic component exists and, therefore, potential lines of germplasm may be efficiently selected for the studied traits.

VI.15 Mechanisms of drought tolerance in pearl millet

Golombek, S., Theek, T.

Institute of Crop Science, University of Kassel, Steinstr. 19, 37213 Witzenhausen, Germany, (golombek@wiz.uni-kassel.de).

Ten days old pearl millet plants (*Pennisetum glaucum* L.) were exposed for 10 days to severe drought in a climate chamber. Drought was induced by withholding water until the soil reached an pF value of 3.7, which was then maintained. The relative humidity was 40/60 % (day/night). In another experiment five days old seedlings were exposed for two days to different levels of air humidity in desiccators for gentle dehydration. In the 20 days old plants drought reduced the osmotic potential of the leaves from values between -0.8 und -1 MPa to values between -1.5 und -2 MPa. Glucose and fructose contributed to the osmotic adaptation of the youngest leaf, but not to the osmotic adaptation of the third leaf from the apex. The activities of the acid soluble invertase and of the cell wall bound invertase increased in the youngest leaf in response to drought. In the third leaf, osmotic adaptation was substantially mediated by potassium accumulation. A group of proteins, the LEA (late embryogenesis abundant) -proteins, is supposed to contribute to the dehydration tolerance of plant cells. Western blots have shown that in pearl millet drought can induce an accumulation of LEA2 and LEA3 proteins in leaves and roots of 20 days old plants in contrary to many other plant species. It has been also shown that the mRNA of LEA2 is substantially increased due to drought. LEA1 protein is accumulated only during young seedling stages under control and drought conditions.

VI.16 Performance of improved maize varieties under low and high Nitrogen conditions in the Guinea Savannas of Nigeria.

Kamara, A.Y., Kling, J., Sanginga, N., Ajala, S.O.

International Institute of Tropical Agriculture (IITA)
(A.Kamara@cgiar.org), c/o L.W. Lambourn & Co., Carolyn House
26, Dingwall Road, Croydon CR9 3EE, England.

Nitrogen is the most limiting nutrient in maize production in the humid and sub-humid tropics. Due to cost and unavailability, inorganic fertilizer use in sub-saharan Africa is limited. Considering the effects of N-stress in sub-Saharan Africa, cultivars that perform well under both N-stressed (low-N) and well fertilized (high-N) conditions are desirable. A low-N tolerant variety trial that included promising varieties and hybrid checks was conducted in Mokwa and Zaria, Nigeria in the cropping seasons of 1999 and 2000. The treatments consisted of 13 and 10 entries for 1999 and 2000, respectively and three N levels (0, 30, and 90 kg/ha) arranged in split-plot design with four replications. In both years, there were significant differences among varieties for grain yield and most agronomic traits measured, but genotype by nitrogen interactions were generally not significant. The second cycle (C2) of the Low N Tolerant Pool (LNTP) had the highest grain yield among varieties at 0 and 90 Kg N/ha in 1999. The same trend was observed in 2000 when the latest cycle from LNTP (LNTPC3) performed better than the previous cycles at the two N levels. There was evidence of good progress of selection from the previous cycle of LNTP. In addition to grain yield, dry matter accumulation at 5 WAP, number of green leaves, thousand grain weight, number of rows per cob were highly significant. LNTPC1, LNTPC2 and LNTPC3 had lower number of rows per cob but consequently had higher thousand-grain weight than the rest of the varieties.

Symposium VII

Management of Biotic Stresses

VII.1 From Chemical Farming to Modern Biotechnology: Debugging an Agricultural Development Myth

Herren, H.R., Waibel, H., Engelhardt, T.

International Centre of Insect Physiology and Ecology, POBox 300772, Nairobi, Kenya, Institut für Gartenbauökonomie, Universität Hannover, Herrnhäuser Str. 2, 30419 Hannover (hherren@icipe.org)

This paper challenges one of the stereotypes of agricultural development, frequently repeated by agricultural experts and lobbyists. Their main argument is that the public needs to support modern biotechnology in order to increase food production in developing countries. It is believed that such goal could only be reached if partnerships with so-called life science companies is established. Such partnerships are based on an assumed complementarity between public sector and private sector research. Furthermore, the public goods character and the poverty focus of international agricultural research especially of the CGIAR system is generally assumed. The paper challenges such myth before the background of empirical evidence and the theoretical consistency of the argument being put forward. It is shown that the emphasis of development efforts on agricultural producers and the overreliance on the input supply industry as partner has damaged the image of agriculture and is at least partly responsible for the diversion of funds away from agriculture. Contrary to the self-centred complaints about decreasing attention for agricultural productivity increase and the theoretically questionable "underinvestment in agricultural research" hypothesis an alternative approach is being presented. In this approach the focus is on development efforts that start from the consumer rather than from the technology supply site. Rather than viewing agriculture in isolation the relative advantage of a multi-sectoral approach to economic and social development is being explored. Particular attention is given to science-based human capacity building through modern approaches of applying information technology for small-scale farmers as a alternative to shifting the yield frontier.

VII.2 The IPM Farmer Field School

Dilts, R.

The IPM Farmer Field School (or FFS) provides farmers with the education they need to sustainably manage their agro-ecosystems. The first FFS was conducted in irrigated rice in Indonesia during the rainy season of 1989-1990 as part of the Indonesian National IPM Program. The FFS became the educational approach used in national IPM programs supported by the FAO Inter-Country Program for Integrated Pest Control in Rice in South and Southeast Asia. By the mid-1990's FFS were being conducted throughout Asia and Southeast Asia in rice as well as vegetable and estate crops. By the late 1990s, the IPM Field School approach was being applied in regions outside of Asia, most notably Africa. The FFS provides small farmers with practical experience in ecology and agro-ecosystem analysis. Farmers acquire the analytical skills that they need to practice IPM and create solutions to the agro-ecosystem problems that they face. The IPM FFS is based upon four principles. The principles provide a guide to what farmers should be able to do because of participation in an FFS. These principles are: (1) Grow a healthy crop, (2) Conserve natural enemies, (3) Conduct regular field observations, (4) Become IPM experts. The first principle means that FFS participants will need to be able to apply good agronomic practices and understand plant biology. This should help alumni to optimize their yields as well as grow plants that can withstand disease and pest infestations. The second principle implies that FFS alumni will reduce their use of insecticides. To do this FFS participants will need to understand insect population dynamics and field ecology. The third principle asserts that IPM requires of farmers the ability to regularly observe, analyze, and take informed decisions based on the conditions of their agro-ecosystems. The fourth principle posits that because of local specificity, farmers are better positioned to be taking the decisions relevant to their fields than agriculture specialists in a distant city. Hence, FFS alumni should be able to apply IPM in their fields and also be able to help others do so. The FFS approach features several departures from earlier IPM farmer training and agriculture extension approaches. Included among these innovations are field based season-long learning for farmers, field experiments, a focus on plant biology and agronomic issues, a new method for agro-ecosystem analysis, the inclusion of human dynamics activities, and a learning approach that stresses participatory discovery learning. The FFS experience provides farmers with an educational foundation upon which they can further build to enhance their abilities to employ not only IPM, but also other knowledge intensive forms of agriculture.

VII.3 Biodiversity and biotechnology: impact on global plant production

Kern, M.

Aventis CropScience, Technology Strategy & Resources, Industrial Park Höchst, K 607, D-65926 Frankfurt/Main, Germany, (manfred.kern@aventis.com)

Worldwide approximately 75,000 edible plants exist, 7,000 among these are for nutrition purposes, 20 are extensively used, 5 have changed the world during the past century (China bark, sugar, tea, cotton, potato). The 5 main world crops of today and for the next 20 to 30 years are: wheat, maize, soybean, rice and oilseed rape. The quality of those crops has to be protected and improved. In the year 2001 more than 70 transgenic crops were already registered worldwide. These include cotton, witloof chicory, potato, squash, maize, soybean, oilseed rape, papaya, tobacco, tomato and carnation. Indeed 45 million hectares worldwide are actually cultivated with genetically modified plants. 1017 pairs of nucleotids comprising the basic components of life: C=Cytosin; A=Adenin; G=Guanin; T=Thymin (C, A, G, T) represent the total diversity of all beings. This diversity provides the raw as well as the genetic material of the total agricultural production and thereby the nutrition of world population. The ancient code of life is meanwhile deciphered and legible, enabling new choreographies. Biotechnology / green genetic engineering provides a new instrument for supporting effective agriculture at long term. If timely and correctly used, it can contribute to protect global biotopes, biodiversity on arable land and the potential of crop diversity. Finally this represents a new arrangement of resources - even of genetic resources - in compliance with the 'Agenda 21'. Evolution takes place by billions of new combinations of C and A and G and T, which on one side should be protected by man and on the other side can or must be used. The life protecting and long term use of biodiversity is a duty of vital importance for total mankind. Examples concerning the impact of biotechnology on global plant production will be given.

VII.4 Protected cultivation - an approach to sustainable vegetable production in the humid tropics.

Borgemeister, C., Poehling, H.-M.

Collaborative project of the Faculty of Horticulture, Hannover University, the Asian Institute of Technology, Bangkok, the Kasetsart University, Bangkok, and the Institute of Plant Diseases, Bonn University

At present vegetable production in South-East Asia is characterised by a strong dependency on chemical plant protection, with all the inherent environmental and health hazards for farmers and consumers. Moreover, agricultural and horticultural food production in the metropolitan areas is of increasing importance for global food security. In our project we thus intend to develop through a holistic research approach an environmentally friendly, and sustainable vegetable production system for the humid tropics, using tomatoes as model crop. In the humid tropics one of the biggest constraints for vegetable production during the rainy season are heavy rainfalls that can often result in total crop loss. Hence our approach will focus on locally-adapted techniques of protected cultivation. Protected cultivation systems, using screen houses with a solid roof construction, will open up new venues for biological control of pests and diseases. The screens will enable us to physically exclude lepidopteran fruit borers, which are some of the most notorious pests of field-grown tomatoes. Moreover, during the last decades serious efforts have been committed to biological pest control in greenhouses in temperate zones, mainly through augmentative releases of beneficial arthropods like predators and parasitoids. However, these techniques need to be adapted to the local conditions in South-East Asia. In addition, we will develop new approaches for biological and integrated control of tomato diseases. In our project we intend to combine fundamental and applied research in a multi-disciplinary fashion, involving scientist from various fields like entomology, plant pathology, plant nutrition, agronomy and agricultural engineering. This interdisciplinary and collaborative research approach will lead to the development of a model for a modern vegetable production system in the humid tropics that is both sustainable and less harmful for the environment.

VII.5 Comparison of methods for evaluation of Cassava cultivars for resistance to African Cassava Mosaic disease

Ariyo, O.A.^{1,2}, Dixon, A.G.O.¹ Atiri, G.I.²

1International Institute of Tropical Agriculture, Ibadan, Nigeria (o.ariyo@cgiar.org). 2 Department of Crop Protection and Environmental Biology, University of Ibadan, Nigeria

ACMD caused by several related viruses is a major constraint to cassava production in Africa and the utilization of resistant cultivars is considered the most effective and sustainable way of controlling the disease. In cassava breeding programs, screening of cassava breeding lines is conducted by exposing clonal plants to natural infections and recording over a time period disease incidence (DI) and intensity of disease symptoms (index of symptom severity, ISS). A scale of 1-5 is used to score for severity in infection and this approach is the standard procedure to evaluate resistance. Several models have been utilized for assessment and categorization of disease resistance in cassava, each with a slightly different emphasis. For evaluation of breeding lines, the use of an enlarged rank-sum method has been effectively used in measuring different aspects of yield stability. A method for disease assessment which is based on relating yield reductions to the "area under the disease progress curve", AUDPC, is also proposed and providing a very tight correlation between the cumulative level of disease and the resulting yield loss. Both methods: rank-sum and AUDPC, were compared for calculation of disease resistance levels in cassava and the confidence of both methods to reveal similar assessments was determined using the Spearman rank correlation. Twenty-three improved Cassava lines from the International Institute of Tropical Agriculture (IITA) and two local land races were evaluated for resistance to ACMD by recording DI and ISS over a period of fourteen weeks under high disease pressure. By applying rank-sum and AUDPC for calculating disease resistance, it was found that both methods result in a comparable assessment of the resistance levels of cassava with a Spearman rank correlation of >99%, indicating a high confidence of the tests to reach similar results. However, compared to rank-sum, AUDPC models do not require a cumbersome ranking of DI and ISS scores. Hence, this method was found most appropriate for assessing resistance to ACMD in cassava breeding lines.

VII.6 Evidence of establishment of *Cotesia flavipes cameron* (Hymenoptera: Braconidae) and its host range expansion in Ethiopia

Getu, E., Overholt, W.A., Kairu E.W.

International Centre of Insect Physiology and Ecology, P.O.Box 30772, Nairobi, Kenyatta University, P.O.Box 43844, Nairobi, Kenya

In 1991, the International Centre of Insect Physiology and Ecology (ICIPE) introduced *Cotesia flavipes* Cameron (Hymenoptera: Braconidae) into Kenya for biological control of *Chilo partellus* (Swinhoe) (Lepidoptera: Crambidae). Prior to the release of the parasitoid in the field, laboratory studies were conducted on the host range and host finding behaviour to determine the potential impact on native stem borers and non-target species. The first release was made in Kenya at the coast in 1993 and the parasitoid successfully established in Kenya. Due to successful establishment in Kenya the project expanded to other countries in eastern and southern Africa. In 1998 ICIPE signed a memorandum of understanding with the then Institute of Agricultural Research (IAR), now Ethiopian Agricultural Research Organization (EARO), to conduct collaborative activities towards the release of *C. flavipes* for the control of *C. partellus*. The first activity carried out before release was to conduct country-wide survey for stem borers and their natural enemies. The country-wide surveys were conducted in 1999 by sampling 150 fields in major maize and sorghum growing areas of Ethiopia at the vegetative and grain filling stages of the crops. In Each field, four 4X4 m quadrates were examined for percent infestation. Additionally, 10 heavily infested plants at the vegetative stage, and five at the grain filling stage were dissected to recover stem borer eggs, larva and pupa and their natural enemies. Insects were reared in the laboratory for species identification and for parasitoid or pathogen development. During the survey, the cropping pattern and the presence/absence of wild hosts within the fields and within a radius of 100 m outside of the fields were recorded. Soil samples at 5, 10 and 15 cm were taken and analyzed for total nitrogen level and organic matter content. Similar procedures were followed in 2000 except the survey was made only during the grain filling stage, and soil samples were not taken. All insects collected were sent to ICIPE, Nairobi for identification. *C. flavipes* was present in Ethiopia in all surveyed regions, although it had never been released in the country. In the survey, four lepidoteran and one coleopteran stem borers were found. *C. flavipes* was found parasitizing three of the lepidopteran stem borers; *C. partellus*, and two noctuids, *Sesamia calamistis* (Hampson), and *Busseola fusca* (Fuller). The probable origin of *C. flavipes* population in Ethiopia is from Somalia where ICIPE released the parasitoid in 1997 along the Shebele River very near to the border of eastern Ethiopia. In the previous surveys, *C. flavipes* was not found in Ethiopia. Additionally, the recovery of *C. flavipes* from *B. fusca* was notable, as previous work in Kenya showed that *B. fusca* was not a suitable host.

VII.7 Application of antagonistic rhizobacteria to control *Meloidogyne incognita* on tomato

Olzem, B., Hauschild, R.

Soil-ecosystem Phytopathology and Nematology, Institute for Plant Diseases, Universität Bonn, Nussallee 9, D-53115 Bonn, Germany.
(*r.hauschild@uni-bonn.de*)

Root-knot nematodes (*Meloidogyne spp.*) cause severe economic losses in tomato production worldwide. Control of nematodes has been accomplished mainly on the basis of methyl bromide soil fumigation. Resistant cultivars are not being used as resistance breaks down under high temperatures. Methyl bromide, which will officially be banned for use in the near future, needs effective replacement technology for integrated control. In our project we attempt to develop new and environmentally safe alternative approaches to control root-knot nematodes on tomato by microbial enhancement of planting material. The impact of different plant-health promoting rhizobacteria on reduction of root galling by *Meloidogyne incognita* was studied and effective strains were selected. A reduction in the numbers of *Meloidogyne incognita* egg masses and root galls was obtained for four strains. The levels of pest control due to the bacterial antagonists as well as the mechanisms that may be involved in biological control will be discussed. We are currently studying the possibility of induced resistance as potential control mechanism. Establishment of biocontrol procedures into agricultural practice essentially depends on suitable application methods. Based on a better understanding of the control mechanisms and of physiological properties of the bacteria advanced bacterial formulations are being developed to improve the control intensity.

VII.8 Identification of conditions under which *Phytophthora capsici* forms oospores in planta

Heine, G., Ploetz, R., Haynes, J.

*University of Florida, Tropical Research and Education Center,
18905 SW 280th Street, Homestead, FL 33031-3314 USA.*

Phytophthora capsici Leonian is a heterothallic Chromistan plant pathogen in the subtropics and tropics. It causes diverse diseases of least 48 host taxa, and is most damaging during periods of high rainfall. The pathogen is comprised of three genetically and pathogenically distinct subgroups, CAP1, CAP2 and CAP3. Only CAP1 strains affect herbaceous hosts such as squash, *Cucurbita pepo* L., and pepper, *Capsicum annuum* L. Oospore formation is a most important step in the life cycle of members of the CAP1 subgroup. Unlike CAP2 and CAP3 isolates, CAP1 isolates do not form chlamydospores. Thus, oospores are the primary survival structures for the CAP1 subgroup. In addition, because meiosis occurs in the fertilized oogonium, new pathogenicity and fungicide resistance phenotypes can be generated during the formation of these propagules. In previous work, both the A1 and A2 mating types of *P. capsici* were present in squash fields that we assayed in South Florida. To further investigate the potential for oospore formation, we examined the conditions under which this event occurred. In studies with detached pepper leaves and a highly fertile pair of A1 and A2 isolates, free moisture was shown to be a key factor in oospore formation. Optimum production occurred only when leaves were immersed or in constant contact with water, and few or no oospores formed under intermittent mist, in closed plastic bags or on wire screens over water reservoirs. Time and temperature were also important factors. Maximum production occurred after 8 days at 18°C. Production also occurred at 16, 20 and 26°C, but not at 6, 12 and 32°C. Very few oospores formed on intact pepper plants under continuous mist in a glasshouse (ca. 28°C). Although the potential for oospore formation clearly exists in the studied production areas, our results indicate that the conditions under which oospores of *P. capsici* form are somewhat specific. The implications and future directions of this research will be discussed.

VII.9 Recent Trends in International Activities in Plant Pathology on the Internet

Kraska, T.

Institute for Plant Diseases, University of Bonn, Nussallee 9, 53115 Bonn, Germany, (kraska@uni-bonn.de)

In recent years the information made available through the internet exploded. As a user it is difficult to keep the track or to decide between high and low quality websites. For plant pathology the internet became an invaluable tool to communicate and to exchange information. This is due to the fact that information is available without any delay all over the world and everybody can access it (unless the use is restricted). Major advantages of the internet in the field of plant pathology can be concluded for diagnosis, risk assessment, forecasting and alerting services. Beside these tools for practioneers a major impact of the internet can be seen for interactive teaching and learning platforms. And last true online Journals and Conferences will be created. And last but not least e-commerce. So Agriculture and Plant Pathology as part of it will use the internet as the tool for exchanging information and for communication. Disease Alerting services will be a major focus in the near future. The traditional ways of communication by phone or fax will be taken over by the internet and combinations of internet and mobile phone technologies (e.g. SMS). CD-ROM based services will also switch to internet based tools or as a combination of it. First buy the CD-ROM and get the updates and online services for that product for free. It could also be a mix of different technologies. And maybe teaching and learning will undergo the most dramatic changes. Will the use of interactive internet-based plat forms overcome the traditional ways of teaching and learning? In this context a new kind of globalization could take place. Study in one country and living in another. Many examples will demonstrate the state of art of these technologies and what might be possible in the future.

VII.10 Effects of natural products on soil organisms and plant enhancement

Mulawarman¹, Hallmann, J.¹, Bell, D.², Kopp-Holtwiesche, B.², Sikora, R.A.¹

1 Institut für Pflanzenkrankheiten, Nussallee 9, D-53115 Bonn; 2 Cognis Deutschland GmbH, Henkelstraße 67, D-40551 Düsseldorf

TerraPy(r), Magic Wet(r) and Chitosan are soil and plant revitalizers based on natural renewable raw materials. These products stimulate microbial activity in the soil and promote plant growth. Their importance to practical agriculture can be seen in their ability to improve soil health, especially where intensive cultivation has shifted the biological balance in the soil ecosystem to high numbers of plant pathogens. The objective of this study was to investigate the plant beneficial capacities of TerraPy, Magic Wet and Chitosan and to evaluate their effect on bacterial and nematode communities in soils. Tomato seedlings (*Lycopersicum esculentum* cv. Hellfrucht Frühstamm) were planted into pots containing a sand/soil mixture (1:1, v/v) and were treated with TerraPy(r), Magic Wet(r) and Chitosan at 200 kg ha⁻¹. At 0, 1, 3, 7 and 14 days after inoculation the following soil parameters were evaluated: soil pH, bacterial and fungal population density (cfu g soil⁻¹), total number of saprophytic and plant-parasitic nematodes. At the final sampling date tomato shoot and root fresh weight as well as *Meloidogyne* infestation was recorded. Plant growth was lowest and nematode infestation was highest in the control. Soil bacterial population densities increased within 24 hours after treatment between 6-fold (Magic Wet) and 25-fold (Chitosan). Bacterial richness and diversity were not significantly altered. Dominant bacterial genera were *Acinetobacter* (45.1 %) and *Pseudomonas* (24.4 %) for TerraPy ; *Pseudomonas* (28.9 %) and *Acinetobacter* (24.6 %) for Magic Wet ; *Pseudomonas* (83.2 %) for Chitosan and *Bacillus* (40.4 %) and *Pseudomonas* (31.6 %) in the control. Increased microbial activity also was associated with higher numbers of saprophytic nematodes. The results demonstrated the positive effects of natural products in stimulating soil microbial activity and thereby the antagonistic potential in soils leading to a reduction in nematode infestation and improved plant growth.

VII.11 Biocontrol activity of rhizobacteria against *Fusarium* wilt on tomato is related to induced resistance

Mwangi, F.M., Hauschild R.

Soil-ecosystem Phytopathology and Nematology, Institute for Plant Diseases, Universität Bonn, Nussallee 9, D-53115 Bonn, Germany.
(r.hauschild@uni-bonn.de)

The fungal wilt pathogen *Fusarium oxysporum* f. sp. *lycopersici* causes severe economic losses in horticultural production worldwide. Control of this disease has been accomplished to some extent by resistance in some crops and in most cases by methyl bromide soil fumigation, the latter to be officially banned in the near future. In our work rhizobacteria that reduce the impact of *Fusarium* on tomato have been identified. Six antagonistic bacterial strains were investigated for effects against *Fusarium oxysporum* f.sp. *lycopersici* on tomato. In greenhouse experiments plants treated with *Bacillus sphaericus*, *Pseudomonas fluorescens*, and *P. putida* before infection with *F. oxysporum* showed significantly less wilting and had higher shoot weights when compared to the untreated plants. These strains are used for microbial enhancement of transplants. Studies on the mode-of-action of these effective rhizobacteria are essential for optimal formulation and practical application to planting material. Direct interactions between the rhizobacteria and *F. oxysporum* were investigated in different systems. To investigate resistance induction, separated application of pathogen and antagonist was achieved by split-root experiments and also by injection of *F. oxysporum* into the stem while the bacteria are applied on the roots. Disease development after injection of *F. oxysporum* in plants whose roots are treated with *B. sphaericus* is significantly reduced when compared to untreated infected plants. This may suggest induction of resistance to *F. oxysporum* by this isolate. Bacteria-induced changes in plant metabolism were analysed by extraction of phenolic compounds and separation by Thin Layer Chromatography. Differences in patterns of phenols between treated and untreated plants were detected. Differentially appearing bands are being identified. These changes also indicate a change in plant metabolism related to defense against *F. oxysporum*.

VII.12 Quarantäneschaderreger in Kenya - Konsequenzen für ein afrikanisches Land und die Vermarktung seiner Produkte

Schrage, R.¹, Hindorf, H.²

*1 Pflanzenschutzdienst der Landwirtschaftskammer Rheinland,
Siebengebirgsstr. 200, D-53229 Bonn 2 Institut für
Pflanzenkrankheiten der Universität, Nussallee9, D-53115 Bonn*

Quarantäneschaderreger sind weltweit meldepflichtig, d.h. bei Befall oder Befallsverdacht muß der zuständige Pflanzenschutzdienst eingeschaltet werden. Befallene Pflanzen dürfen nicht in den Handel gelangen und weiter kultiviert werden. Der zunehmende internationale Handel mit Pflanzen und pflanzlichen Erzeugnissen erhöht jedoch die Gefahr der Einschleppung von Krankheiten und Schädlingen, die unter Umständen erhebliche wirtschaftliche und ökologische Auswirkungen entfalten können. Für eine rentable Produktion von Pflanzen und pflanzlichen Erzeugnissen ist die Befallsfreiheit von Krankheiten und Schädlingen von ausschlaggebender Bedeutung, sowohl für die nationale Versorgung als auch für den internationalen Handel. Daher sollte im Vordergrund stehen, das Einschleppen von Krankheiten und Schädlingen aus anderen Regionen zu verhindern und gleichzeitig sicher zu stellen, daß das Vermehrungsmaterial höchsten Qualitätsansprüchen und pflanzengesundheitslichen Anforderungen entspricht. Zusätzlich gilt eine Bekämpfungspflicht für die Krankheit oder den Schädling, die Vernichtung befallener Pflanzen, Abgrenzung des Befalls und umfangreiche Hygienemaßnahmen. Unter den Quarantäneschaderregern tritt in Kenya seit Jahrzehnten der Kaffeerost, *Hemileia vastatrix*, auf, der vermehrt allerdings nur in für *Coffea arabica* marginalen Anbaugebieten vorkommt. *Ralstonia solanacearum*, der Erreger der Schleimfäule der Kartoffeln, ist einer der meldepflichtigen Quarantäneschaderreger, der jüngst in Deutschland eingeschleppt wurde. Die Bakteriose hat einen breiten Wirtspflanzenkreis und ist in wärmeren Regionen weit verbreitet. Neben Solanaceen sind u.a. Pelargonien (Geraniaceae) befallen, über die die Krankheit mit Jungpflanzenimporten aus Kenya nach Deutschland eingeschleppt wurde. *R. solanacearum* an Pelargonien ist optisch nicht von den Symptomen der bakteriellen Welke *Xanthomonas campestris* pv. *pelargonii* zu unterscheiden. Typisch ist auch hier das Welken gut gewässerter Pflanzen, meist an den älteren Blättern beginnend. Bei akutem Befall kommt es zu einer raschen Ausbreitung und schnellem Absterben der Pflanzen. *P. solanacearum* ist mit drei physiologischen Rassen bekannt. Bei den an Pelargonien (*Pelargonium zonale* hybr.) aufgetretenen Infektionen konnte die an kältere Regionen angepaßte Rasse3 Biovar 2 identifiziert werden, die auch die Schleimfäule der Kartoffeln verursacht. Die größte Gefahr für die Ausbreitung der Krankheit besteht durch infiziertes Ausgangsmaterial, das dann den heimischen Kartoffelanbau gefährden kann. Aus diesem Grund sind in

Deutschland strengste Gegenmaßnahmen zu erwarten, die hier erläutert werden sollen. Neben Quarantäneschaderregern spielt in Kenya an bedeutenden Exportkulturen *Agrobacterium tumefaciens* an Schnittrosen eine wichtige Rolle. *A. tumefaciens* verursacht an den meisten in Monokultur gezogenen Rosensorten krebsartige Geschwülste im Wurzelbereich und kann durch Bodenentseuchung nicht mehr bekämpft werden.

VII.13 Kontrolliert integrierte Schnittblumenproduktion in Ecuador

Schrage, R.

*Pflanzenschutzdienst der Landwirtschaftskammer Rheinland,
Siebengebirgsstr. 200, D-53229 Bonn*

Deutschland ist mit einem Konsumwert von 8 Mrd DM/Jahr der größte europäische Verbrauchermarkt für Schnittblumen. Da der Selbstversorgungsgrad nur ca. 20 % beträgt, spielen Importe eine große Rolle. Bedeutende Exportländer sind z.B. Kolumbien, Ecuador und Kenya. Bei der Produktion von Schnittblumen in Drittländern sind in der Vergangenheit immer wieder die Produktionsbedingungen im Hinblick auf den Pflanzenschutzmitteleinsatz, die Umweltschonung und Menschenrechte kritisiert worden. Als Reaktion darauf haben sich verschiedene Zertifizierungsstandards und Siegel entwickelt, die hier vorgestellt werden. Das Siegel mit dem derzeit größten Rückhalt bei den Menschenrechtsorganisationen, wie z.B. terre des hommes, Brot für die Welt, FIAN etc., ist das FLOWER LABEL. Dieses Label ist eine gemeinsame Initiative von Menschenrechtsorganisationen, Gewerkschaften und des deutschen Blumenhandels und hat das Ziel, bei der Schnittblumenproduktion die Grundrechte der Arbeiterinnen und Arbeiter sowie des Umweltschutzes zu garantieren. Das Label unterscheidet sich von anderen Siegeln durch die Berücksichtigung von internationalen Sozialstandards (ILO) und die Einforderung von Gewerkschaftsfreiheit und Regelungen der innerbetrieblichen Mitbestimmung. Die technischen Standards für die Produktion orientieren sich an internationalen Anforderungen des Pflanzenschutzes und den Arbeits- und Umweltbedingungen (z.B. FAO Kriterien). Im Bereich Pflanzenschutz werden Minimierungsstrategien für Pflanzenschutzmittel mit hoher Toxizität gefordert (WHO 1) und die allgemeine Durchführung eines integrierten Pflanzenschutzes angestrebt. Einen Schwerpunkt bilden der Anwenderschutz und Sicherheitsmaßnahmen beim Umgang mit Pflanzenschutzmitteln. Die Kriterien des Programms werden von unabhängigen Prüfern vor Ort kontrolliert. Schwerpunkte und auch Vorreiter der Zertifizierungen waren und sind die Rosenbetriebe in Ecuador.

VII.14 Tracheomycosis (*Gibberella xylarioides*) on coffee (*Coffea arabica*)

Girma, A.*, Hindorf, H.**

* *Ethiopian Agricultural Research Organization, Jimma Agricultural Research Center, P.O.Box 192, Jimma, Ethiopia.* ** *Institut für Pflanzenkrankheiten, Universität. Nussallee 9, D - 53115 Bonn.*

Tracheomycosis is a typical vascular disease syndrome of coffee incited by a fungal pathogen, *Gibberella xylarioides* (*Fusarium xylarioides*). The fungus was earlier reported to be a well-known pathogen of other *Coffea* species in West and Central Africa in the 1950s. The disease was observed again in Zaire (Congo) in the early 1980s and noticed for the first time in Uganda in 1993, it is now causing economic losses on *Robusta* coffee in both countries. In Ethiopia, the occurrence of *G. xylarioides* on *C. arabica* was established in the early 1970s. More recently, systematic surveys of tracheomycosis were conducted in coffee fields with known wilt disease history in some localities of southwestern Ethiopia. All coffee trees in each sample field were diagnosed for external and internal symptoms, and the fungal fruiting bodies were also examined. The assessment was accompanied by sample collection for isolation and identification of the causative agents in the laboratory. The most typical characteristic symptom of infection on mature trees and young coffee seedlings is partial (unilateral) wilting. Internally, dark reddish (brown) discoloration is commonly exhibited on the wood after gently scratching the bark of diseased plants. The mean disease incidence ranged from 45 % at Gera to 69 % at Bebeke, with certain variations between coffee fields at each locality. The fungus was identified from most of the sample components, and a large number of sexual and asexual spores were also observed from fruiting bodies collected in the field. This survey along with the earlier works implicated that tracheomycosis develops to an important disease on *Arabica* coffee, too. One of the speculations for the cause of its reemergence in Congo is that aggressive strains of the pathogen may have arisen. In this case, there was no wilt disease on some *Robusta* coffee in Ethiopia, conversely *Arabica* coffee has not been affected in Congo and Uganda during the recent outbreaks. Thus further collaborative investigations are being underway in order to contain and manage the disease sustainability. These are comparisons of *G. xylarioides* isolates from *Arabica* and *Robusta* coffee, including earlier isolates of the 1970s; using morphological, genetical and molecular markers; accompanied by proving host specialization of the pathogen on *Arabica* and *Robusta* coffee.

VII.15 Host shift of the diamondback moth *Plutella xylostella* L. in Kenya: Influence of peas as host plant on the parasitoid *Diadegma mollipla* (Ichneumonidae)

Roßbach, A.

Institut für Pflanzenpathologie, Abt. Agrarentomologie, Universität, Grisebachstr. 6, D-37075 Göttingen

The oligophagous diamondback moth (DBM), *Plutella xylostella* L., is one of the most destructive pests on crucifers worldwide. It is known for its specificity for crucifers and so far, no reports exist about this moth feeding in nature on other plant families. In Central Kenya, in the region of Lake Naivasha, a diamondback moth population shifted to snowpeas (*Pisum sativum*) causing heavy damage to this crop. This host shift should have an influence on the interaction with natural enemies. One of the most frequent parasitoids attacking the diamondback moth in Kenya is the ichneumonid *Diadegma mollipla*. In laboratory studies parasitism and growth of *D. mollipla* reared on pea-DBM compared with DBM feeding on cabbage was measured. Differences in development time, pupal weight, parasitism rates and host preference will be shown. The study was conducted at the International Center of Insect Physiology and Ecology (ICIPE) in Nairobi integrated into the DBM Biocontrol Project.

VII.16 Activity of extracts from tropical and sub-tropical spices and herbs against plant pathogenic fungi

Mekuria T., Steiner, U., Dehne, H.-W.

*Institute for Plant Diseases, Nussallee 9, D-53115 Bonn, Germany,
(uzsxdc@uni-bonn.de)*

Plant extracts solely or as secondary metabolites are among the modern tools in sustainable, safe and environmentally sound ways of plant protection. Spices and herbs in nature contain different bioactive substances promoting human welfare in various forms since ancient periods. Traditionally, growers used spices as preservatives of foods and agricultural products against insect pests and disease damages in many households of the tropics and sub tropics. But there is a lack of or only scarce information for the use of spices and herbal extracts in controlling of foliar pathogenic fungi. The objective of this study was screening of tropical and sub tropical spices and herbal extracts for their potential sources of antifungal substances under *in vitro* and *in vivo* conditions. The studied spices and herbs included 23 species for instance *Cassia* spp., *Piper nigrum*, *Carum carvi*, *Urtica dioica*, *Coriandrum sativum*, *Artemisia dracuncululus* and *Foeniculum vulgare*. 10 g of pulverised samples were mixed with 100 ml of 70 % ethanol for extraction in warm water bath (60 °C). *In vitro* screening of extracts (1% m/v) on PDA against conidial germination of *Cladosporium cucumerinum*, *Botrytis cinerea* and *Alternaria solani* revealed that there was great variability in antifungal natures of the tested preparations. High levels of fungicidal activity (50 to 100%) in inhibition of conidial germination was attained by using extracts from *M. piperita*, *C. sativum*, *P. nigrum*, *C. carvi* and *U. dioica*. Extracts of *P. nigrum* and *U. dioica* showed high degree of mycelial growth inhibitory effects on *C. cucumerinum* and *A. solani*. Spices and herbal extracts were assayed for their disease protective potentials against *A. solani*, *Phytophthora infestans* and *Oidium lycopersicum* on tomatoes; *Erysiphe graminis* f. sp. *tritici* on wheat and *Uromyces appendiculatus* on bean cotyledons. In most studied cases, extracts of *Piper* spp., *C. carvi*, *U. dioica*, *Cassia* spp. and *F. vulgare* showed significant disease protection activities. Considering the better and persistent *in vitro* and *in vivo* performances, an activity guide substance of *P. nigrum* seed extract was further isolated, identified and characterised with the aid of TLC and HPLC analysis. Hence, the study enabled the detection of active ingredients from spices and herbs to assist environmentally safe ways in the management of fungal pathogens.

VII.17 Erfahrungen mit dem Internetportal 'Global Campus 21' im Rahmen des Nord-Süd-Dialogs

Baumgart, M.¹, Schuler, B.²

*1 Internationale Bildungsstätte für Agrarökologie aus Gut Ostler
Burgweg 19, 53123 Bonn. (M.Baumgart-Gut.Ostler@t-online.de). 2
Deutsche Stiftung für Internationale Entwicklung, Wielinger Straße
52, 82336 Feldafing.*

Der Global Campus 21 (<http://www.gc21.de>) stellt ein internetbasierendes Lernportal dar, was gemeinschaftlich von der Carl-Duisberg-Gesellschaft (CDG) und der Deutschen Stiftung für Internationalen Entwicklung (DSE) aufgebaut wird. Den Teilnehmenden (zumeist Fachkräfte aus Entwicklungsländern) wird per Internet das Online-Lernen im allgemeinen erleichtert sowie spezielle Angebote für den Nachkontakt im Anschluß an eine Fortbildungsmaßnahme zur Verfügung gestellt. Der gc21 ermöglicht ferner die per Internet gestützte Information, Kommunikation, Koordination, Kooperation und Publikation in den unterschiedlichsten Fachgebieten. Die Teilnehmenden können unabhängig von Ort und Zeit Informationen suchen und austauschen (Links zu Fachinformationsseiten), in Gruppen an gemeinsamen Projekten arbeiten (shared-work-spaces) oder sich individuell mit Hilfe von Lernprogrammen fortbilden (web-based-training). Die langfristigen Ziele des Global Campus 21 liegen darin, das lebenslange globale Lernen zu unterstützen, aktuelles Fachwissen effizient anzueignen, den Austausch zwischen Teilnehmern unterschiedlicher Herkunft und Generation zu verbessern, Netzwerke zu fördern, den Informationsfluß zwischen Teilnehmern, Experten, Partnern und CDG/DSE zu verbessern, sowie ein attraktives und aktuelles Nachkontaktangebot zu gestalten. Neben den bereits bestehenden Fachinformationsseiten (FIS) im Bereich der Land- und Forstwirtschaft sowie der ländlichen Entwicklung (z.B. Natürlicher Pflanzenschutz), hat die Zentralstelle für Ernährung und Landwirtschaft der DSE bereits einige Internet-Netzwerke mit initiiert z.B. NECOFA: Netzwerk für nachhaltige Landwirtschaft (ECO-Farming) in Afrika oder ein Pflanzenschutznetzwerk ehemaliger Teilnehmer in Lateinamerika. In neuen Projekten werden nun virtuelle Seminare und Foren entwickelt wie z.B. shared work spaces im tropischen Pflanzenschutz und Pflanzenbau. Mit Hilfe verschiedener Kommunikations-tools können virtuelle Seminare je nach Bedarf, Inhalt und Zielgruppe programmiert werden, die es den Teilnehmern erlauben sich in Fachdiskussionen oder durch online-Konferenzen (chat) auszutauschen. Die Plattform verfügt über weitere Kommunikationsbausteine die zum Teil mit Unterstützung von Teletutoren moderiert werden. Hierdurch werden neue Profil-Anforderungen an virtuelle Moderatoren oder Dozenten nötig, um das Spannungsfeld einer fachlich fundierten, interkulturell empfindsamen und internet-technischen Seminarvirtualität zu steuern.

VII.18 Cell wall degrading enzymes produced in vitro by isolates of *Fusarium graminearum* differing in virulence

Wanyoike, M.W., Buchenauer, H.

Institute of Phytomedicine, University of Hohenheim, 70593, Stuttgart, Germany.(Wanyoike@uni-hohenheim.de)

The relationship between in vitro production of cell wall-degrading enzymes and virulence of 15 *Fusarium graminearum* isolates were investigated. Enzymatic activities of cellulase, xylanase, and pectinase were measured when *F. graminearum* isolates were grown in minimum salt medium containing 1% of cellulose, xylan, and pectin, respectively as the sole carbon source. Cellulase activity was the highest followed by xylanase and finally pectinase. Pectinase activities were detected 2 days after incubation while those of xylanase and cellulase were detected 3-4 days after incubation. The same isolates were examined regarding their virulence on the resistant wheat cultivar 'Arina' and on the susceptible wheat cultivar 'Agent' after a single spikelet inoculation in the outdoor pot experiments. All the isolates used were pathogenic (determined by their area under disease progress curve) on both wheat genotypes. Isolates differed significantly in their aggressiveness. There was no correlation between the activities in vitro of the three enzymes and the pathogenicity of the isolates.

VII.19 Varietal Resistance against *Xanthomonas campestris* pv. *manihotis* (Xcm), the causal agent of the Cassava Bacterial Blight (CBB)

Witt, F.¹, Wydra, K.^{1,2}, Mavridis, A.¹, Rudolph, K.¹

1 Institut für Pflanzenpathologie und Pflanzenschutz, Georg-August-Universität Göttingen, Grisebachstr. 6, D-37077 Göttingen, Germany. (fwitt@gwdg.de). 2 Institut für Pflanzenkrankheiten und Pflanzenschutz, Universität Hannover, Herrenhäuser Str. 2, 30419 Hannover, Germany.

CBB causes yield losses on Cassava (*Manihot esculenta*) of more than 50% in African countries. Nine cultivars from Africa and South America were tested under standardized conditions for resistance against a highly virulent strain of Xcm. By spray-infiltration with 10⁶ cfu/ml typical symptoms were caused on leaves of all tested varieties. Symptom development on the inoculated leaves of a resistant cultivar was delayed by 2-3 days. The disease became systemic within 60 d (wilting, die-back, gumming) on the susceptible cvs., but not on the resistant cv.. Maximum bacterial concentrations of 10⁷ cfu/cm² leaf area (resistant cultivar TMS 30572) and 10⁹ (susceptible cv. Ben 86052) were reached on young leaves after 6-9 d, on old leaves after 12-15 d. Systemic spread of bacteria appeared to be impeded in the petioles, especially in the resistant cv.. The resistant cultivar TMS 30572 appears promising in order to reduce losses by CBB in Africa.

VII.20 Induced Resistance In Crops Against Parasitic Weeds

Buschmann, H., Sauerborn, J.

University of Hohenheim, Dept. of Agroecology in the Tropics and Subtropics, D-70593 Stuttgart, Germany.

The holoparasitic weed *Orobanche cumana* is a serious threat for sunflower (*Helianthus annuus*) cultivations in Eastern and Southern Europe as well as in Western Asia. So far neither common control methods of the pathogen nor breeding for resistance in sunflower proved to be successful. In recent times there is evidence that the use of specific chemicals, like benzothiadiazole, may activate the resistances in plants based on the principle of systemic acquired resistance (SAR). This proved to be very efficient for several cereals and their bacterial or fungal pathogens but was never used with sunflower nor with parasitic flowering plants. Seeds of the parasite *O. cumana* were collected 1990 in Bulgaria from sunflower. Seeds of the host plant *Helianthus annuus*, variety Iregi, from Hungary were used. The effect of benzo(1,2,3)thiadiazole-7-carbothioic acid S-methyl ester (BTH), the active ingredient of Bion(r) (Novartis) on the underground stages of *O. cumana* was evaluated in root chambers and paper roll assays. Chemical analysis of root extracts and structure identification was performed as described elsewhere. Treatment of sunflower seeds with 40 ppm of the resistance inducing chemical benzo(1,2,3)thiadiazole-7-carbothioic acid S-methyl ester (BTH) for 36h completely prevented infection in root chambers. In pot trials using $2,86 \times 10^{-4}$ g *Orobanche* seeds per g soil as inoculum total number of *O. cumana* was reduced by 84 and 95% in the 60 ppm BTH treatment in the first and second trial, respectively. Corresponding to the concentrations of BTH there was an increasing production of secondary metabolites in the sunflower roots. The functions of these compounds are defense related as well as antioxidative. The data show that the phenomenon of Induced Resistance is not restricted to viral, bacterial and fungal disease and demonstrate the great benefit of this protection strategy as an effective component of future plant production systems.

VII.21 Biological control of the antagonistic rhizobacterium *Rhizobium etli* strain G12 toward the root-knot nematode *Meloidogyne incognita* on different host plants

Mahdy, M., Hallmann, J., Sikora, R.A.

Soil-Ecosystem Phytopathology and Nematology, Institute of Plant Pathology, Bonn University, Nussallee 9, D-53115 Bonn, Germany

Root-knot nematodes of the genus *Meloidogyne spp.* are the most economically important group of plant parasitic nematodes causing high damage and yield losses on most cultivated crops on a worldwide basis especially in warmer climatic regions and on sandy soils. The nematode is a major pest problem in crop production in most Mediterranean countries and in newly reclaimed desert areas in Egypt. Application of microorganisms antagonistic to *Meloidogyne spp.* could be an alternative to chemical control of nematode diseases. In the present study we investigated the effect of the rhizobacterium *R. etli* G12 against *M. incognita* on different plant species. The crops tested included: tomato, cucumber, cotton, soybean and pepper. Plants treated and nontreated with *R. etli* G12 were examined for root gall index and number of egg masses. The results showed that the bacterium *R. etli* G12 was able to reduce nematode infestation on a broad spectrum of host plants. The rate of nematode reduction, however, varied between the tested crops. The gall index was reduced between 17% for cotton and 50% for tomato and the number of galls between 34% for cucumber and 47% for tomato. The reduction in the number of egg masses varied from 37% for soybean to 70% for pepper. The variation in the level of biological control between crops might be caused by (1) differences in host-bacteria compatibility due to differences in host exudate makeup that either favour or disfavour bacterial colonisation (2) differences in root growth behaviour between crops or (3) the potential of the bacteria to induced resistance in some crops but not others. The results demonstrated that *R. etli* G12 is a promising biocontrol agent towards *M. incognita* on a broad host plant spectrum.

VII.22 The Economics of Pesticide Overuse in Cotton Production in Pakistan

Orphal, J., Waibel, H.

*Institut für Gartenbauökonomie, Fachbereich
Wirtschaftswissenschaften University Hannover, Herrenhauserstr. 2,
D-30419 Hannover (orphal@ifgb.uni-hannover.de).*

The liberalisation of agricultural input markets in Pakistan has resulted in a rapid increase in pesticide use in cotton. Cotton is one of Pakistan's major cash crops and agricultural export earner. While the negative externalities of chemical pesticides are meanwhile well documented the question whether increased pesticide use has significantly contributed to productivity growth is not always clear. Very often uneconomically high levels of pesticides have occurred especially in cotton, in some cases leading to the non-sustainability of cotton production. In this study the productivity of pesticides is being assessed using the damage control function approach based on data of farm level surveys in Multan district in Punjab. Data have been collected in two areas, one where cotton has been grown for a long time and another one where cotton production started only recently. One of the hypothesis of the studies was that in an area with long cotton growing the dependence on pesticides and thus their use level is likely to be higher. Furthermore, health problems as related to pesticides were investigated. The results showed that while pesticide overuse occurs frequently in both areas, pesticide use levels are higher in the area where cotton was introduced recently despite of lower productivity. At the same time health costs are at similar levels although farmers knowledge in the area with longer cotton growing were higher. The results challenge some of the conventionally held beliefs that pesticide overuse is dependent on the state of the ecosystem. At the same time the appropriateness of the expected utility theorem frequently used to explain pesticide overuse is questioned thus lending some support to the validity of prospect theory in explaining farmer's pesticide use decisions.

VII.23 Integrated control of cassava bacterial blight: transfer of research results to NARS in Africa and adaptation of control measures to specific agro-ecological conditions

Wydra, K.^{1,2}, Ahohuendo, B.³, Banito, A.^{1,4}, Cooper, R.M.C.⁵, Dixon, A.⁶, Kemp, B.⁵, Kpemoua, K.⁴, Rudolph, K.², Verdier, V.⁷, Witt, F.^{1,2}, Zinsou, V.^{1,3}

1 *Inst. of Plant Diseases and Plant Protection, Univ. of Hannover.* 2 *Inst. of Plant Protection and Plant Pathology, Univ. of Göttingen.* 3 *University of Benin, Fac. of Agriculture.* 4 *ITRA, Lome, Togo,* 5 *School of Biology and Biochemistry, Univ. of Bath, UK,* 6 *IITA, Ibadan, Nigeria,* 7 *IRD, Montpellier, France*

Results of a collaborative EU-financed project, a follow-up of a BMZ-financed research project at the International Institute of Tropical Agriculture (IITA) (1994-1999), with the partners listed above - the German institutes being the coordinators - are presented. In field studies conducted by national agricultural research systems (NARS) in Benin and Togo, control measures for cassava bacterial blight, elaborated in a former project at IITA, such as intercropping, use of resistant varieties, weed control etc. were combined and tested under various agronomic and ecological conditions. The investigations resulted in up-to-date survey data on major cassava diseases in Togo - data from other West African countries had formerly been collected at IITA -, the identification of locally and regionally well adapted control measures, using locally preferred, resistant varieties, intercropping with locally used crops, soil amendments with available material, fertilization, and recommendations on sanitary measures to reduce the disease. Local varieties had been planted in multi-locational trials in various ecozones under inoculation with local, virulent strains as well as challenged by a set of highly virulent strains from various geographic origin under glasshouse conditions. Research results of European partners were partly verified under African conditions, such as testing of the cassava genome mapping population for reaction towards African strains in order to identify genetic markers and/or resistance related genes. Pathotypes of African strains were identified, leading to a differential reaction of genotypes of the mapping population. Detailed inoculation studies and the quantifications of bacterial population dynamics *in planta* indicated the occurrence of resistance mechanisms in leaves and stems, as well as genotypes expressing resistances on both or only on one level. Complementary studies elucidated some mechanisms of resistance, on biochemical as well as molecular genetic level, and molecular host-pathogen interactions. Wax analysis revealed an indication of a possible role of leaf surface waxes in resistance. New methods for detection of *Xanthomonas campestris* pv. *manihotis* (*Xcm*), using immunological and genetic techniques, were developed.

VII.24 Analysis of tomato-infecting whitefly-transmitted geminiviruses in Central America

Frischmuth, T.¹, Ofner, H.¹, Fernandez, O.²

1 University of Stuttgart, Biologisches Institut, Abt. Molekularbiologie, Pfaffenwaldring 57, 70550 Stuttgart, Germany, (thomas.frischmuth@po.uni-stuttgart.de). 2 Instituto de Investigacion Agropecuaria de Panamá (IDIAP), Apartado 6-4391, El Dorado, 6A-Panama.

Tomato yields from fields and greenhouses are often reduced due to viral infection. In many cases geminiviruses have been identified as the viral agent causing these diseases. Geminiviruses are small plant viruses with circular single-stranded DNA (ss-DNA) genomes encapsidated in twinned particles. Members have been divided into four genera on the basis of their genome organisation and host range. Members of the genus Begomovirus infect dicotyledonous plants, are whitefly-transmitted and have bipartite genomes (DNAs A and B). Until recently, tomato plants grown in Central America were not known to be seriously affected by geminiviruses. This has changed during the last few years. Geminivirus-associated epidemics are currently threatening tomato production in Central America (e.g. Mexico, Puerto Rico and Costa Rica) and the southern United States. Geminivirus-like symptoms were observed in tomatoes in Panama central provinces since 1983 but infections became a problem in 1991 with the increase of whitefly populations due to insecticide misuse. Yield losses of industrial tomato were estimated at 2 metric tons during 1991-92 and 1992-93. The outbreak 1996-1997 produced yield losses of more than 3 metric tons. The total losses for tomato growers were equivalent to about 1 million US\$ during the period 1991-1997 on the industrial tomato harvest. We have cloned and sequenced the causal agent, the bipartite begomovirus Tomato leaf curl virus (ToLCV/Pan). For the last four years samples of infected tomatoes and wild plant species were collected and analysed. This survey led to the identification of several distinct tomato-infecting geminiviruses.

VII.25 Biological and integrated control of brassica pests in Papua Newguinea

Saucke, H., Dori, M.F., Schmutterer, H.

*University Kassel, FB 11, Ecological Crop protection
(hsaucke@wiz.uni-kassel.de).*

The major constraint to produce good quality cabbage in Papua New Guinea (PNG) poses a complex of insect pests which includes the Diamondback Moth *Plutella xylostella* (L.), as the most prominent species. In order to evaluate the prospects of a classical control approach economically important major pests and their natural enemies were surveyed in three cabbage growing areas with distinct climatic regimes at low- mid- and high elevation. In the PNG highlands the release and successful establishment of the *P. xylostella*-specific parasitoid *Diadegma semiclausum* (Hellen) reduced crop losses remarkably since 1995. In the arid PNG lowlands the introduced *P. xylostella*-parasitoid *Cotesia plutellae* (Kurdjumov) exerted 80% parasitism in an experimental site although, a lasting establishment was not achieved in that location. Natural enemies of associated lepidoptera such as *Crocidolomia pavonana* (Zeller), *Spodoptera litura* (F.), *Helicoverpa armigera* (Hübner) and *Hellula undalis* (F.) were economically insignificant. Thus, insecticidal control, preferably selective, was still a requirement. Best results were achieved in field trials with the commercial neem formulation NeemAzal? (*Azadirachta indica* A. Juss.) and an aqueous neem seed kernel extract from seeds of PNG grown trees. The prospects of integrating *C. plutellae* into a reduced insecticide spraying program as well as alternative cultural control measures are discussed.

VII.26 Comparative analysis of arthropoda impact on leaf litter decomposition in “Rain-forestation Farms” on Leyte, Philippines

Daub, M., Göltenboth, F.

Institute of Plantproduction and Agroecology in the Tropics and Subtropics (380), University of Hohenheim, 70593 Stuttgart, (goltenfr@uni-hohenheim.de).

On two different sites concerning altitude, soil and former use, but all under reforestation using the innovative “rainforestation technology”, the function of leaf litter arthropoda within the decomposition process was investigated from May to September 2000. Two different reforestation sites, replanted with indigenous or long time locally adapted forest tree species, have been compared with a reference site in a natural secondary rainforest. One site, called Punta, is characterized by limestone and low altitude, the other, called ViSCA, by basaltic rocks and higher altitude. Litter bag trapping of arthropodes showed dominance of mites and collembolans. Ants seem to play also an important role. Higher arthropoda diversity in the leaf litter increased with tree species diversity and variety of available microhabitats. The feeding activity of the leaf litter fauna was revealed by the Baits Lamina Test Method (Törne, 1990). Lowest site specific feeding activity was found at the reference site in the secondary forest. A preliminary analysis of turn-over rates of the leaf litter during 130 days indicates a higher decomposition rate at the secondary forest reference site than in any of the other sites under investigation. With these preliminary results concerning the impact of arthropoda on leaf litter decomposition on different reforestation sites in the humid tropics a contribution can be made to the knowledge about decomposition and turn-over rates in leaf litter of regenerating former forested areas. The impact of these effects will be presented and discussed.

Symposium VIII

Water Resources, Use and Conflicts

VIII.1 Irrigation Performance Assessment in Thailand - Problems of Monitoring and Evaluation

Rieser, A., Höynck, S.

Performance assessment is a tool to be applied in the management of large-scale irrigation systems. The case study approaches to the socio-economic aspect as part of the research project entitled: "Systems Analysis for Irrigation Performance Assessment". The case study addresses the management of a Phitsanulok Irrigation System in the northern part of the central plain of Thailand, a system with an irrigated area of about 100.000 ha, mainly paddy. The approach to performance assessment starts from concepts developed by IIMI (International Irrigation Management Institute). The performance indicators suggested by IIMI are tested by using secondary data from several institutions involved in the development of the irrigation area. Additionally, results from two farm surveys will be used to assess the socio-economic performance of the irrigation system. The surveys are conducted to gain a thorough picture of farming systems in the irrigation system, their household structures and decisions as well as the role of irrigation for on-farm performance. Those results can be related to information from technical analysis of the irrigation system, which is contributed by other partners from the research project, and thus shed more light on the expressiveness of socio-economic performance indicators in irrigation management.

VIII.2 **Water Resource Management in Lebanon: Simulation of the Qaraoun reservoir operation with regard to the effects on the whole Litani System**

Kretschmer, N.

Institute for Technology in the Tropics, University of Applied Sciences, Cologne (FH Köln), Betzdorfer Straße 2, D-50679 Cologne, (Nicole.Kretschmer@dvz.fh-koeln.de)

The Litani River System (the most important river system in Lebanon) has been studied extensively since the early 1950's. Original plans for the development of the system included the construction of reservoirs to store water during the wet season and to use it for different purposes. The main storage facility within the Litani Project, the Qaraoun reservoir, has a capacity of 220 MCM. The reservoir was originally planned as a multi-purpose facility within the Litani Project, with the objective to supply water for hydropower, irrigation and domestic uses. However, releases from the reservoir have been almost only used for hydropower production since it was built in 1965. The main reason for the single-objective use until now is of political nature due to the 17 years civil unrest period in Lebanon. Nevertheless because of the increasing water scarcity and new demand areas the allocation of the available water resources need to be reviewed and the operation policy of the reservoir has to be reassessed. A lot of projects are being discussed and some of them are under construction already regardless of the maximum yield the system can cover. A Simulation model, based on historical inflow records is developed and serves to study different scenarios with different operating policies. The simulation and its results of single - as well as multi - objective water use scenarios to investigate a) the effects of the implementation of new projects of different water sectors (domestic as well as irrigation) on hydropower production and b) the yield of the present and possibly future system configuration.

VIII.3 Watershed Based Water Quality Monitoring Systems - the Case of the Aconcagua River in Chile

Ribbe, L.

*Institut für Tropentechnologie, University of Applied Sciences
Cologne (FH Köln), Betzdorfer Str. 2, D-50679 Köln, Germany
(lars.ribbe@fh-koeln.de)*

The role and functioning of water quality monitoring systems as supplier of information for management decisions is introduced. The technical design of a monitoring system should be based on sound data on the natural and human environment like hydrologic characteristics, water uses and impairments, legal framework, information needs, and institutional capacities. These factors are analysed in a preliminary study for the case of the Aconcagua watershed located in the fifth region in the central part of Chile. The watershed is characterized through Mediterranean type climate, has a total area of around 7500 km² with an average discharge in the order of 30 m³/s. Agriculture is the dominant water user accounting for 84 % of total water consumption. Main sources of pollution are untreated domestic and industrial effluents as well as agricultural diffuse pollution. The location of pollution sources is documented and applied to deduct optimum sampling location. The minimum sampling frequencies are analysed for the management goal "detection of long term trends in water quality". Variable selection is based on type of pollution sources upstream and dominant water uses downstream. The context of water resources management in the region and a suggestion for the integration of the monitoring system in the overall water information strategy are outlined.

VIII.4 Increasing the water productivity of rice-based irrigation systems ? The case of Sakassou irrigation system, Côte d'Ivoire

Hundertmark, W.

Water Management Consultant, Gustuav-Weihrauch-Weg 3, 22359 Hamburg, Germany

In a 1997 base survey conducted in Côte d'Ivoire, the West Africa Rice Development Association identified considerable diversity and complexity of rice irrigation systems. The availability of water and its proper management was identified as an important constraint to the productivity of systems. In this study, a comprehensive analytical framework is used, which gives particular attention to performance assessment and strategy development for improved water productivity of rice-based systems. In a case study carried out at the Sakssou rice irrigation system, Côte d'Ivoire, it is found that one cubic-meter of depleted water is processed into 0.44 kg of paddy, which is about half of the assumed potential productivity of water. The depleted fraction is about 53% of water totally available to the system. Large quantities are accounted for as utilizable and non-utilizable outflow. In order to fully exploit the potential for improved productivity, a strategy is suggested, which follows four principal pathways: (1) improving the quality of services; (2) increasing the production per unit of water consumed; (3) reducing non-beneficial depletion, and (4) tapping uncommitted outflows. In the long term, an increase in water productivity to 0.8 kg per m³ is suggested. This is seen as a continued effort of medium-term interventions. In addition, uncommitted outflows from various system levels are to be tapped and used more productively through harmonizing water supplies and demand, improving canal flow characteristics, and re-establishing field storage and reuse during peak demand periods. Economically it is suggested to concentrate on the first, more productive cropping cycle and adopt a water conservation strategy during the second, less productive cropping cycle. Thus, sufficient storage can be carried over in order to sustain high production of the first cropping cycle in the following year.

VIII.5 Water Efficiency and Technology Choices in Irrigation Systems: A Case Study on Farm Behavior in the Chinese Province Shaanxi

Fang, L., Nuppenau, E.-A.

Department of Agricultural Policy and Market Research, University of Giessen, Germany

Water scarcity is a great challenge for agriculture in 21st century. Research on water efficiency has been given priority in many countries. In particular, in countries that foresee water shortages, like in China, increased efficiency in water use is seen as a way to foster food production, to protect the environment, and to solve social conflicts in water rights, simultaneously. Increased efficiency in water use requires private and public investments. Private investments in technical equipment that enables more precise application of water by farmers such as drip irrigation instead of furrow irrigation is costly and farmers may not invest due to low economic efficiency of investments. Too high water prices maybe an obstacle to investment, because farmers will abandon irrigation and go for dry land farming. If the water price is too low, no incentives for water saving exist. Public investments in canals could decrease water costs at points of sale to private users and only the interaction of complementary activities of the private and public sector may promise to deliver the urgently need rationalization of water, whereas water is wasted now. In a case study on the Chinese province Shaanxi we investigate farm behavior with respect to investments in different technologies. Optionally, farmers can continue to irrigate with furrow irrigation, invest in different types of sprinkler and drip irrigation or invest on farm technologies that best fit their economic conditions. The government controls public water prices, but farmers can use private wells to assure water deliveries. Moreover, in a model we combine water delivery and use option and show how increased water efficiency contributes to increase food production.

VIII.6 The influence of areal rainfall variability on surface flow regimes in the central highlands of Ethiopia

Osman, M.¹, Sauerborn, P.², Skowronek, A.¹, van de Giesen, N.³

1 Universität Bonn, Institut für Bodenkunde, Nussallee 12, 53115 Bonn, Germany. 2 Universität Köln, Seminar für Geographie, 50931 Köln, Germany. 3 Universität Bonn, ZEFc, Walter-Flex-Strasse 2, 53113 Bonn, Germany.

Rainfall variability and its impact on the hydrologic regime highly affect the water resource management and use in the central highlands of Ethiopia. Variability of surface flow is an important factor for land and water resources management. It has not yet been well investigated. This study assesses the impact of seasonal and long-term areal mean rainfall on surface flow. The study focuses on the Awash River Basin - an area of high economic importance. It receives 70% of the annual rainfall during the main rainy season (June-September) and the rest during the small rainy season (March-April). Monthly hydrometric data ranging (1982-1997) of Hombole, Kessem, Melka Kunture, Modjo and Teje were statistically analysed. Mean annual areal rainfall (mm) was used for the study too. The surface runoff at various gauging stations varies considerably. Descriptive statistical analysis shows that the runoff measurements are approximately normally distributed. The fluctuation in long-term areal annual and summer rainfall had clear consequences on surface runoff. The trend of precipitation variability was directly reflected on surface runoff. The trends in long-term surface runoff at the selected gauging stations can not be exclusively explained by areal rainfall variability - but by local precipitation characteristics. Improved gauging station density with reasonable spatial distribution can substantially improve the assessment results of the relationship between variability in areal precipitation and surface hydrologic regime and, hence, foster decision making on sustainable land and water management. Further research on the influence of precipitation variability on hydrologic regime should be conducted at watershed level. Moreover, the impact of soil physical properties such as soil water storage capacity, land-use and land cover of the area on surface runoff should be undertaken.

VIII.7 Water supply position in Benin/West Africa- study of the demand page of a water-balance

Schopp, M.

*Institut For Agricultural Policy, Market Research And Economic
Sociology, Nußallee 21, D-53115 Bonn, Germany,
(schopp@agp.uni-bonn.de)*

In the course of a dissertation, which is part of a co-operation project named "IMPETUS" between the University of Bonn and Cologne, there will be a research on the demand side of the water-balance in Benin. The results are captured in an economic model, so that prognoses and strategies of development can be derived in the future. In the process a demand-curve has to be put up. In the international comparison Benin with an available fresh water quantity of at present 4232 m³, does not belong to the "water-poor" or "water-scarce" countries of the world. In accordance to the secondary data Benin has sufficient water reserves. During the first field stay it became clear that the missing economic and technical support leads to a shortage of the water resource. This situation position makes it necessary to compare presently available water quantity with the used quantity and to access as the future water requirement of different competitive users groups. The competing users can be divided in three groups: Industry, population/tourism and agriculture/animal breeding. It is to be counted on the fact that each subgroup will expand its water requirement, specially due to the population growth. A special emphasis of the investigation is to analyse the statistical connection of socio-economic data, with the water consumption. During the field work the water consumption of some villages has to be compared with the water consumption of the city. At the same time available statistics are analysed and examined critically and own data collection is executed. At great importance is the participatory observation, particularly because our collection parameters are not portable to the local conditions.

VIII.8 Economic and Ecological Restructuring of Land and Water Use in Khorezm, Uzbekistan: A Project

Martius, Chr., Vlek, P.L.G., Schoeller-Schletter, A., Wehrheim, P.

Center for Development Research (ZEF), Walter-Flex-Strasse 3, 53113 Bonn, Germany, (c.martius@uni-bonn.de).

In the Aral Sea basin, cotton is produced in large areas of irrigated land, but irrigation water use is highly inefficient, leading to severe soil degradation (salinization) and the shrinking of the Aral Sea, with the well-known ecological consequences. The efficiency of water and land use must be increased to improve local livelihood. For that purpose it is imperative that natural resource management, economic and legal-administrative restructuring be integrated. ZEF, with UNESCO and several research institutions in Uzbekistan, has developed a joint research project proposal for the Khorezm province (lower Amu Darya river). The project will address the efficiency of soil and water utilization via landscape restructuring and improvement of agricultural efficiency; the improvement of the contamination of soils and water with salts and pesticides, control of the pollution with air borne salt and dust transports, and improvements in drinking water supply; economic analyses of agricultural products, water and contaminants; and legal-administrative analyses of land tenure, water administration, and user rights.

Symposium IX

Biodiversity

IX.1 Conserving agricultural biodiversity in situ: A scientific Basis for Sustainable Agriculture

Jarvis, D.

International Plant Genetic Resources Institute (IPGRI), Via dei Tre Denari, 472/a 00057 Maccaresse, Rome, Italy.

In situ conservation on-farm of crop diversity is carried out by farming communities. The primary task for those concerned with conservation and with the maintenance of crop diversity in situ is to understand when, where and how this will happen, and who will maintain the material and how those maintaining the material can benefit. Four areas of investigation are undertaken, which have set the necessary scientific agenda needed to support farmers and local communities in in situ conservation on farm: (1) What is the extent and distribution of the genetic diversity maintained by farmers over space and over time? (2) What are the processes used to maintain the genetic diversity on-farm? (3) Who maintains genetic diversity within farming communities (men, women, young, old, rich, poor, certain ethnic groups)? (4) What factors (market, non-market, social, environmental) influence farmer decisions on maintaining traditional varieties? Key has been the recognition that farmers may characterise the units of crop diversity they manage not by a name but by a set of traits labeled "Farmers' Units of Diversity" or FUD. Vital for diversity maintenance are management practices to reduce abiotic and biotic stress and seed supply systems. Understanding who maintains diversity on-farm allows targeted support to the appropriate gender, age and ethnic groups. These results together with economic analysis of market and non-market factors that influence farmers to maintain diversity has enable (1) the creation of a portfolio of development options to enhance benefits of crop diversity to farmers and (2) the development of methods, including protocols for in situ data management to mainstream the use of local crop genetic resources into the agricultural development arena.

IX.2 Germplasm collection of native legume species in Bac Kan Province, Northeast Vietnam

Heider, B., Schultze-Kraft, R.

Institute of Plant Production and Agroecology in the Tropics and Subtropics, University of Hohenheim (380), D-70593 Stuttgart, Germany (biodiv@uni-hohenheim.de)

A series of collecting missions was initiated in January 2000 by the University of Hohenheim, Institute of Plant Production and Agroecology in the Tropics and Subtropics, Stuttgart, Germany, in co-operation with the Vietnam Agricultural Science Institute (VASI), Hanoi, Vietnam, in order to collect germplasm of native legume species in the highlands of northeast Vietnam (Bac Kan Province). The objective was to (1) contribute to the preservation of endangered genetic resources; (2) broaden the genetic base of material for eventual plant selection and/or breeding programmes; and (3) increase the availability of legume options for improved feed, soil fertility, and erosion control in local production systems. A total of 88 sites were visited during four missions and 527 accessions (acc.) of native legume species were gathered. At each site, passport data were recorded. Altitude varied between 50 and 930 m asl and soil pH from 4.0 to 6.4. Frequently collected species were *Desmodium heterocarpon* (69 acc.), *Senna tora* (55 acc.), *Desmodium gangeticum* (40 acc.), *Flemingia macrophylla* (38 acc.), *Dendrolobium triangulare* (36 acc.), *Tadehagi triquetrum* (29 acc.), *Pueraria phaseoloides* (20 acc.), *Uria lagopodoides* (18 acc.), *Crotalaria pallida* (15 acc.), *Pueraria montana* (13 acc.), *Uria crinita* (12 acc.), *Desmodium heterocarpon* ssp. *angustifolium* (11 acc.), *Pycnospora lutescens* (10 acc.), and *Dunbaria podocarpa* (10 acc.). The most frequently collected species with a potential as forage plants, cover crops or fallow improvement species are *Dendrolobium triangulare*, *Desmodium heterocarpon*, *Desmodium gangeticum*, *Flemingia macrophylla*, *Pueraria phaseoloides* and *Tadehagi triquetrum*. Those species were found at sites with acid soils and over a range of altitudes. However, many heavily disturbed sites showed that genetic erosion is increasing. In order to counteract progressing genetic erosion there is a need for more sustainable land use, combined with ex situ and in situ conservation measures.

IX.3 De-central Seed Production and Selection - for Food Security and Sustainable Conservation of Plant Genetic Diversity

Häge, W.

*Deutsche Gesellschaft fuer Technische Zusammenarbeit; Seed
Certification Project; 4D, El Gezira Street, Cairo, Egypt.
(walter.haege@gmx.de)*

The production of staple food crops in Africa is still based on a relatively wide range of species and traditional selection has created numerous plant populations with valuable adaptations to diverse natural and agronomic environments. However farmers need improved varieties and quality seed in order to avoid yield losses and secure food production. Modern plant breeding and formal seed supply chains have so far not covered the needs of farmers and consumers in Africa. Privatisation in seed production and liberalisation of seed trade raise the possibility of widespread distribution of some improved varieties and may result in the loss of genetic diversity. Conservation of germplasm in genebanks or in certain in-situ systems most probably require permanent funding. Access and use of the material by farmers is supposed to be difficult. Therefore "De-central Seed Production and Selection" is presented as an integrated approach (1) to evaluate varieties or populations on a local level and to develop adapted and competitive varieties or populations, (2) to promote the sustainable use of varieties or populations derived from local genetic pools and preserve genetic diversity of food crops, (3) to enable farmers to produce and maintain seed lots of adequate seed quality and to supply them at low prices and (4) to facilitate a benefit sharing or award system encouraging active and good seed producers and breeders. The approach is based on plot trials according to evaluation and selection criteria defined by farmers and consumers. Farmers producing and trading seed in the area may carry out trials, participate in trials and or finance the trials. The approach may encourage breeding and seed production activities of farmers, that equal similar activities of farmers in Europe that marked the beginning of modern seed production and plant breeding.

IX.4 Diversity of traditional coffee production systems in Ethiopia and its contribution for the conservation of coffee genetic diversity

Gole, T.W.¹, Teketay, D.², Denich, M.¹, Borsch, T.³

1 Center for Development Research, University of Bonn, Walter-Flex-Str. 3, 53113 Bonn, Germany. (w.gole@uni-bonn.de). 2 Ethiopian Agricultural Research Organisation, P.O. Box 2003, Addis Ababa, Ethiopia. 3 Botanisches Institut und Botanischer Garten der Universität Bonn, Meckenheimer Allee 170, D-53115 Bonn, Germany

Being the center of origin and diversification of coffee, *Coffea arabica* L., Ethiopia possesses diverse genetic resources of the crop. This is partly due to the diversity of ages old traditional coffee production systems by the Ethiopian farmers. Coffee production systems in Ethiopia can be grouped into four broad categories as: forest coffee, semi-forest coffee, garden coffee and coffee plantations. The first three are traditional production systems by small scale subsistent farmers. The three traditional systems, i.e., forest, semi-forest and garden coffee production systems account for 5-6%, 20%, and 68-69% of the coffee production in the Ethiopia respectively, summing up to 94% of the national produce. A large diversity of coffee germplasm is maintained in farm genepools in Ethiopia. Around 120 coffee land races are cultivated by farmers, of which 45 are from coffee growing regions east of the Great Rift Valley while 76 are from the western part. Through the Ethiopian National Coffee Collection Program, more than 600 coffee types were collected and documented between 1966 and 1984. Today, more than 4500 accessions of coffee collected from the main coffee growing regions in Ethiopia are being maintained in Chochie field gene bank. The maintenance of coffee genetic diversity in the traditional production systems is being threatened by several socio-economic problems like increased population, price fluctuation, other competitive cash crops. The gradient of coffee germplasm degradation increases towards the eastern part of the country. The fate of coffee genetic resources conservation in such system depends on a mechanism which will allow continued traditional system of production on farm lands by enhancing the productivity of such systems. Further research on the functioning mechanisms of the systems and possible ways of enhancing agricultural production efficiency without losing the genetic resources of the crop is recommended.

IX.5 Community Based Management of Animal Genetic Resources

Köhler-Rollefson, I.¹, Lossau, A.v.²

1 League for Pastoral Peoples, Prugelatostr. 20, 64372 Ober-Ramstadt, Germany. 2 GTZ, Postfach 5180, 65726 Eschborn, Germany

Community Based Management of Animal Genetic Resources (CBMAnGR) is a new and innovative concept for the conservation of domestic animal diversity that recognizes the crucial role of farming and pastoral communities in the maintenance of agricultural biodiversity. Corresponding to the call of the Convention on Biological Diversity (CBD) to conserve biodiversity in its original habitats, it represents a dynamic alternative to conventional ex-situ and in-situ conservation approaches and essentially thrives to combine sustainable use of livestock breeds with empowerment and poverty alleviation for farming and pastoral communities. CBMAnGR builds on experiences made during community based NRM projects and recognizes participatory approaches, appropriate institutional support, integration of indigenous knowledge and values as well as skill and capacity building of stakeholders as critical success factors. Other cornerstones include supportive policy frameworks, marketing opportunities, IPR regimes and economic valuation of AnGR. The concept of CBMAnGR was developed during an international workshop held in Swaziland in May 2001 that was organized by SADC, SACCAR, FAO, UNDP, GTZ and the MoA Kingdom of Swaziland. Participants recommended to bring the importance of CBMAnGR to the attention of FAO, to formulate policy frameworks that support research and implementation of CBMAnGR in the Southern African region and to develop policies on the rights of local communities, farmers and breeders and the regulation of access to and benefit sharing of AnGR. For each of the cornerstones identified, interest groups were formed and volunteers nominated to act as facilitators. Further activities and networking have taken place since the workshop. One concrete project that was taken up concerns the marketing of products of the Nguni cattle breed from Southern Africa. A statement about the results of the workshop will also be presented at the COPVI negotiations of the CBD. Nevertheless, further funding and interest by donors is needed in order to implement the concept of CBMAnGR into practice, gain experiences and evaluate its comparative strengths.

IX.6 The Central Documentation for Animal Genetic Resources in Germany (TGRDEU) as part of international information-systems concerning animal genetic resources.

Bremond, J.

*ZADI - Zentralstelle für Agrardokumentation und –information, Abt.:
Informationszentrum für Genetische Ressourcen (IGR) Villichgasse
17, 53177 Bonn (Bremond@ZADI.de)*

During the last more than 100 years, the situation concerning animal breeding changed rapidly. A drastic decrease, which must be seen in biodiversity (e.g. in animal breeding), world-wide, is due to deep changes in natural ecosystems and to the human activities which led to the replacement of local breeds by mostly imported breeds that seem to be more productive. The endangerment of loosing more and more local and very specific adapted breeds is more than obvious. The subjects regarding Animal Genetic Resources (AnGR), which in this respect means the endangerment of genetic diversity, are in discussion and can only be seen in a global interdependence. Thus, many international and political relevant organisations show response for AnGR, above all FAO. In the context of the "Convention on Biological Diversity" it is a call and an obligation to all states, to develop a management for their AnGR, to ensure the maintenance of old and endangered farm animal breeds, which is a contribution for the development of a sustainable agriculture and a rural development for future needs world-wide. Documentation and information concerning this subjects is one of the first duties regarding AnGR. A global and comparable information System therefore is necessary. The DAD-IS (Domestic Animal Diversity - Information System) of FAO is such a system, where all states and countries can bring in their national data. TGRDEU is the German national information-system concerning AnGR, and its data are transmitted to some international information systems, such as the FAO-system. These systems have several tasks to fulfill, so they ought to be a global documentation regarding the situation of AnGR, and they allow an objective comparison between breeds world-wide. Most of the greatest genetic treasures are supposed to be in the tropics. First things, that have to be done here, are comprehensive documentations concerning AnGRs. Our TGRDEU will give an example, in what way this can be done, and in this respect will give an offer to support those countries and states, that are about to do this documentation work.

IX.7 Evaluation of the Floral Characteristics of Barley Accessions from ICARDA's Gene Bank Collection

Ghani, A.H.A.¹, Parzies, H.K.¹, Ceccarelli, S.², Geiger, H.H.²

1 University of Hohenheim, Institute of Plant Breeding, Seed Science, and Population Genetics, 70593 Stuttgart, Germany (c geigerhh@uni-hohenheim.de). 2 ICARDA, P. O. Box 5466, Aleppo, Syria

Previous studies indicated that yielding ability and stability of barley could be improved under unpredictable drought stress by increasing the level of heterozygosity. It has been proposed that outcrossing and consequently the level of heterozygosity may be increased by selecting for large, protruding anthers and vigorous stigmas. For this reason, a representative sample of barley accessions was evaluated at Tel Hadya (ICARDA) for outcrossing related traits in the 1999/2000 growing season. Anther and stigma length as well as anther width were measured under a binocular microscope. Furthermore, anther extrusion was estimated on a 1 to 3 scale, giving score 1 for lines with no or few extruded anthers and 3 for high extrusion. High variability of anther length, anther width, anther extrusion, and stigma length was found in barley accessions of ICARDA's gene bank. Anther extrusion was weakly but significantly correlated with anther and stigma length ($r= 0.296^{**}$ resp. 0.303^{**}). Also, a moderate significant correlation was found between anther length and anther width ($r= 0.500^{**}$) as well as between anther width and stigma length ($r= 0.369^{**}$). However, no significant correlations were found between anther and stigma length or between anther extrusion and anther width. Our results indicate that barley accessions from ICARDA's gene bank are a rich source of variation for out-crossing related traits. It seems likely that the potential for a high outcrossing rate can be improved by recurrent selection for anther length, stigma length and anther extrusion. The evaluated material is well adapted to the WANA (West Asia and North Africa) region. This allows to directly improve the level of heterozygosity, i.e. without specific focus on drought tolerance and developmental traits and without the need of introgressing genes from wild relatives.

IX.8 Establishment of a transformation system of pearl millet (*Pennisetum glaucum*)

Girgi, M., Morgenstern, A., Oldach, K.H., Lörz, H.

*Universität Hamburg, Institut für Allgemeine Botanik
(AMPII) Ohnhorststrasse 18, 22609 Hamburg (fb0a009@botanik.uni-hamburg.de)*

Pearl millet is one of the main crops in semi-arid regions and the sixth most important cereal world-wide. It is tolerant to drought and to very acid soils and can be grown in low rainfall areas where maize and sorghum are not profitable. Although resistant against many diseases, pearl millet is susceptible to several fungal pathogens, i.e. smuts and downy mildew which are causing high yield losses yearly. The permanent increase of the world population and the expansion of deserts endanger human nutrition. Due to its good adaptation to drought and heat, pearl millet is an important crop to help attain food security where other cereals fail. Therefore it is of great interest to develop high yielding and pathogen resistant cultivars. In addition to classical breeding, genetic engineering is a promising strategy to introduce valuable traits into pearl millet. For genetic enhancement two preconditions have to be fulfilled: 1. an efficient in vitro culture- and 2. an efficient transformation-system. For the establishment of the in vitro culture system different parameters were tested to determine the optimal culture conditions and the initial explant material. Best plant regeneration rates were achieved with the L3/sucrose medium using immature embryos as explants for the in vitro system. For the transformation of pearl millet the biolistic method was applied using a visible and a selection marker gene. Immature embryos were bombarded with gold particles (0.4-0.8 μm) at a pressure of 1550 psi. First 4 transgenic plants were obtained about six months after bombardment. All transformants are showing a normal phenotype and are fertile. Integration pattern and number of copies of the transgenes in the plants and their progenies were checked by southern blot analysis.

IX.9 Establishment of yam (*Dioscorea spp.*) in vitro cultures; an initial step of preserving their genetic diversity

Leunufna, S., Keller, J.E.R.

Two experimental series were conducted for this study. In the first experiment, explants from aerial tubers were used to introduce yam accessions into in vitro culture. Small size aerial tubers of two yam species, obtained from 9 months old plants grown in a greenhouse were sterilized and cultivated in three different culture media. *D. oppositifolia* gave 68% regeneration of shoots and roots upon introduction which was significantly higher than that of *D. bulbifera* (16%) 4 weeks after culture. Culture media, however, exhibited no statistical difference on regeneration of shoots and roots. In the second experiment, a study was performed on an already existing yam in vitro collection to determine the multiplication rate in the storage process. Thirty three yam accessions, established in two different temperature regimes (20°C for sub-tropical/temperate yams and 25°C for tropical yams), were used in determining the multiplication rate by means of sub-culturing single node including one leaf every two months. Theoretical multiplication rate (TMR) defined as number of obtained explants divided by number of survived explants and practical multiplication rate (PMR) defined as number of obtained explants divided by total number of original explants were calculated. Yams (*Dioscorea spp.*) originated in sub-tropical/temperate areas, theoretically can multiply 2.8 ± 1.48 to 5.61 ± 2.73 times. In practice, however, only multiplication rate of 0.87 ± 0.36 to 2.35 ± 0.70 can be obtained. High percentage of these yams could not survive further sub-culture (16.7%-77.6%) and 4 accessions were lost during establishment. PMR of tropical yams were in the range of 3.05 ± 1.34 to 6.26 ± 3.67 . This was not significantly different from their corresponding TMR (2.20 ± 1.06 to 6.26 ± 3.67). These yams exhibited lower percentage of non-survived explants (0%-20%). Although sub-tropical/temperate yams theoretically are able to multiply almost as much as tropical yams, not all of the explants can multiply in the next sub-culture. Explants of tropical yams are able to multiply upon sub-culture regardless of their position on the donor plant. Care should be taken over the selection of explants, and further research should be done aiming at improving medium and other conditions for multiplication of sub-tropical/temperate yams.

IX.10 Green Pepper (*Capsicum annuum* L) Landrace-Derived Population and Hybrids of Inbreds with High Level of Resistance to Heat and Drought

Mohamed, F.M.

*Department of Horticulture, Assiut University, Assiut 71526, Egypt.
(mofouad@yahoo.com).*

Green pepper production is limited by high temperature especially when combined with deficiency in the available soil moisture. Under adverse high temperature conditions in southern Egypt, substantial amount of green pepper is produced using a local landraces which is greatly variable in fruit size, shape and pungency. The growing plants usually are subjected to interruption in irrigation schedules. The growers produce their own seeds without awareness of outcross or plant rogue. Therefore, these landraces can be considered as mixture of heterozygous genotypes. Potential genetic variation for resistance to heat and drought stress factors may be developed by natural selection in this landraces under such stressful conditions. The objectives of the present study are to: 1) investigate the efficiency of visual bulk-selection versus visual progeny tested selection to develop an elite population with enhance yield combined with resistance to heat and drought, and 2) evaluate hybrids of advanced inbreds derived from this landrace with the sweet pepper cv 'California Wonder' (CW) for improved quality under heat and drought conditions. A landrace mixed collection from local farmers and seed retailers in southern Egypt was used in our study. As result of this study, a population from two S2 progeny tested selections exhibiting higher fruit set, fruit weight and number and total yield than the original population was produced. Visual bulk-selection without progeny test was not effective. Three heat and drought resistant hybrids were produced from crosses of S3 inbreds showing high level of plant homogeneity with the cv 'CW'. They had an improved fruit shape and size. S5 inbred lines, currently, are developed. They may be used further in physiological and molecular studies to asses the mechanisms of stress resistance and identify useful DNA markers assisting breeding.

IX.11 About the economic importance of millipedes on Santo Antao (Cape Verde) using the example of *Spinotarsus caboverdus* Pierrard.

Nascimento, B., Sermann, H.

*Humboldt- University Berlin, Faculty for Agriculture and Horticulture,
Division of Phytomedicine.*

Representatives of the sub-class of the diplopods as plant pests were first verified in 1970. So far, the presence of *Spinotarsus caboverdus* is limited to the islands of Santo Antao and Sao Vicente. There it is subject to an internal quarantine in order to counteract the danger that the pest could spread to other regions in the country through the transport of agricultural products. The species is infamous as a pest that befalls many plants important for the alimentation of the inhabitants. All chemical and biological combat measures so far have not lead to any considerable success and thus brought the cultivation of individual cultures like the potato, for example, to a standstill. Obviously the measures applied so far failed because the regimen and the behaviour of the animals protect them from direct contact with the pesticide. Therefore, new approaches for a combat strategy can only be effective if they are accompanied by the explanation of concrete biological facts regarding this pest. *Spinotarsus caboverdus* very quickly learnt to use the ecological conditions of the island to its advantage and thus managed to spread quickly and with a high population density across the island since its first detection. Their preferred places of residence are fields with leaf deposits on the floor (e.g. banana leaves) and especially rocks, under which the animals like to hide during the day in order to protect themselves from drying out. The highest population density among millipedes in the course of the year can be observed during the time the mangoes mature. Damages to the cultured plants and their fruits can be observed all the year round, though. With the aid of a laboratory cultivation, we want to answer specific questions about the pest's development and reproduction. In our considerations regarding a combating strategy, we prefer natural control mechanisms, as the successful settlement of a useful organism with a lasting efficiency has ecological as well as economical priority for a poor country like Cape Verde.

IX.12 Polymorphism of porcine C3 Gene in Thai Native Pig

Mekchay, S.^{1,2} Wimmers, K.¹, Ponsuksili, S.¹, Vearasilp, T.² Schellander, K.¹

1 Institute for Animal Breeding Science, University of Bonn, Endenicher Allee 15, 53115 Bonn, Germany. (mekchay@itz.uni-bonn.de). 2 Department of Animal Science, Faculty of Agriculture, Chiang Mai University, Chiang Mai 50200, Thailand.

The complement system is an important host defence mechanism against microbial infections in animals. The third component (C3) is the central molecule of the complement system. Activation of the C3 protein plays a significant role in inflammation, phagocytosis and immunoregulation processes to destroy microorganism. Therefore the gene for C3 can be regarded as a candidate gene for disease resistance. In our previous study, we determined the cDNA sequence of porcine C3 gene (access number AF154933) and detected three single nucleotide polymorphism (SNP). The first SNP is a C→A substitution at 1905 nucleotide position detected by PCR-RFLP with restriction enzyme Hsp92I. The second SNP is a G→A substitution at 3,882 nucleotide position and that was genotyped by allele-specific PCR. For the third SNP is a T→C substitution at 204 nucleotide position of intron 13 and was detected by restriction enzyme Taq I. The aim of this study was to determine the SNPs of porcine C3 gene in Thai native pigs. Blood samples of 32 Thai native pigs from regions of Northern Thailand were taken and DNA was isolated. The genomic DNA was utilized for a PCR and genotyping of the Thai native pigs at the three SNPs sites of C3 gene was performed. It could be shown that the three SNPs in the C3 gene segregate among the Thai native pigs. The allele frequencies of the three SNPs in the sample of the Thai native pigs were 0.68 and 0.32 for the C and A alleles of position 1905 of the C3 gene, 0.80 and 0.20 for the C and A alleles at position 3,882 of the C3 gene and 0.58 and 0.42 for the T and C alleles at position 204 in intron 13 of the C3 gene. In contrast, no polymorphism was found among 80 commercial pigs of the breeds German Landrace (n=28), Large White (n=24) and Pietrain (n=23). The Thai native pigs are highly variable at the C3 locus. The genetic variation detected within the Thai native pigs may be associated to phenotypic variation especially of trait related to fitness and disease resistance. Our results demonstrate that animals of native non-selected tropical origin are valuable resource of genetic polymorphism.

IX.13 Musa genetic resources conservation and sustainable utilization

Van den Houwe, I.¹ Swennen, R.¹, Sharrock, S.², Frison, E.²

1 Laboratory of Tropical Crop Improvement, K.U. Leuven, Kasteelpark Arenberg 13, 3001, Leuven, Belgium. 2 INIBAP, Parc Scientifique Agropolis II, 34397, Montpellier Cedex 5, France.

With a total world production of 88 million metric tons, plantains, cooking bananas and various types of dessert bananas provide a principal staple food for millions of people and together they constitute the developing world's fourth most important crop. There are hundreds of cultivars of bananas and plantains, with the greatest diversity being found in backyards and traditional agricultural systems, particularly in South East Asia, the centre of diversity of the crop. Only a very few cultivars are grown by large-scale producers for the export market. The International Network for the Improvement of Banana and Plantain (INIBAP), has assembled over the past 17 years the largest collection of banana varieties in the world. The gene bank, housed at the Katholieke Universiteit in Leuven, Belgium, contains over 1,100 clones. These are stored in tissue culture form under slow growth conditions. Recently, three cryopreservation techniques have been developed and efforts are underway to cryopreserve the entire collection. The gene bank is an invaluable reservoir of genetic diversity of agriculturally important varieties, old landraces and their wild relatives. In 1994, this collection was placed under the auspices of FAO within the International Network of Ex Situ Collections and is held in trust for the world community. Every year, hundreds of samples are made available free of charge to researchers and development workers around the world for characterization, breeding, evaluation and distribution to farmers. So far germplasm has been distributed to 192 institutes in 88 countries totaling more than 50,000 samples. Many banana varieties are susceptible to pests and diseases that adversely affect the biological and economic stability of small farms. In conjunction with NARS, breeding programs and researchers, INIBAP co-ordinates the International Musa Testing Program. This program allows new varieties produced by breeding programs to be tested under varying environmental conditions and different pathogen pressures in a large number of countries world-wide. This activity has resulted in the identification of several more productive and disease resistant varieties suitable for direct use by farmers and small scale producers. Superior varieties that have been distributed from the genebank are starting to be incorporated into the existing agricultural systems in a number of countries. In Cuba, Nicaragua and Tanzania for example, these varieties are having a positive impact on food security, as well as contributing to improved food quality and a better income for small-scale farmers. INIBAP is a program of the International Plant Genetics Resources Institute (IPGRI), a Future Harvest centre.

IX.14 The Information System on Plant Genetic Resources of the N. I. Vavilov Institute of Plant Industry (VIR)

Harrer, S.¹, Omelchenko, A.²

1 Zentralstelle für Agrarinformation und -dokumentation, Villichgasse 17, 53177 Bonn, (harrer@zadi.de). 2 N. I. Vavilov Institute of Plant Industry (VIR), St Petersburg, Russia

Since its establishment in 1894, the N. I. Vavilov Institute of Plant Industry (VIR), St Petersburg, Russia has accumulated impressive quantities of data associated with plant germplasm held in its genebank - one of the most important collection of plant genetic resources in the world. The biggest part of this data have been recorded on cards and paper reports. During the last years, more and more of this information was computerized. But there was still a limited availability of data for people outside the institute. As a result of a joint project between the VIR and the Information Centre for Genetic Resources (IGR) at the German Centre for Documentation and Information in Agriculture (ZADI) in Bonn, the VIR Information System (<http://www.genres.de/vir/>) has been developed, to provide this valuable information for everybody via internet. Following the most recent update, the system now provides information on the structure and history of the Institute. For each department and experimental station there is a short description available, including names and contact details of responsible scientists. A question and answer service also assists in making it more straightforward to contact VIR staff. The most important part of the VIR Information System is the online database. Currently, the institute holds more than 330 000 accessions, representing 2539 species within 304 genera of 155 botanical families. To date, 250 000 accessions of these 330 000 accessions have been verified and access to the passport data of approximately 85% of this collection is now possible through direct searches on the Internet. Access to the database is possible either by using a crops list or by using a search form for all thirteen fields of the database. Decoding tables are also available by downloading zipped files. Over the last year, the site has had an average of about 2.500 hits per month. The aim of this information service is to improve access to and use of the collections held at VIR through the increased availability of the related data.

IX.15 Effect of environment and management on reproduction behaviour of the amphicarpic tropical legume *Centrosema rotundifolium*

Mueller, S.¹, Schultze-Kraft, R.¹, Rodríguez, I.²

1 University of Hohenheim (380), 70593 Stuttgart, Germany, (smueller@uni-hohenheim.de), 2 Instituto Nacional de Investigaciones Agrícolas (INIA) - Centro de Investigaciones Agropecuarias del Estado Anzoátegui, El Tigre, Venezuela

Centrosema rotundifolium (CR) is an amphicarpic legume with a potential as a forage plant for sandy, acid and low fertility soils in the sub-humid tropics. Through amphicarpy - a phenomenon where at the same plant above- and below-ground fruits are formed - this species has the capacity to maintain a grazing-independent soil seed bank from which a population can regenerate. Experiments were conducted on a sandy, acid, low fertility soil in the "Mesa de Guanipa" in Eastern Venezuela, a savanna which is representative for extended areas of neotropical savannas. The effect of management and environmental stress factors on above- and below-ground seed production and resource allocation to reproductive structures of CR were studied. Managerial and stress factors under investigation were (1) intra-specific competition (plant density), (2) inter-specific competition (association with pasture grasses), (3) defoliation intensity (cutting frequency), (4) fire, and (5) fertilization. The results indicate that with increasing cutting frequency reproduction (above- and below-ground) decreased and dry matter production of thickened roots increased. The regrowth meristems on the latter have the potential to contribute to the persistence of CR when seed production is failing. Intra-specific competition and high phosphorus fertilization caused an increased below-ground and decreased above-ground reproduction. In association with different pasture grasses, below-ground reproduction of CR was not affected, except in mixture with *B. brizantha*, where below-ground reproduction decreased; above-ground reproduction was low in all mixtures. Burning in the dry season increases below-ground reproduction decreases above-ground reproduction.. The studies show that under stress CR allocates more resources to below-ground reproductive structures than to above-ground, except in mixture with *B. brizantha* and under high cutting frequency. Due to amphicarpy, CR has a reactive ability ("plasticity") that facilitates the plant to switch its reproduction from above-ground to an increased below-ground reproduction under certain environmental and management stress situations and to an increased above-ground reproduction under non-stress conditions. The below-ground seed production potential of CR becomes evident under the agro-climatic conditions of the study area where a maximum below-ground seed production of 2.3 t ha⁻¹ was recorded. This abundant soil seed bank ensures a quick regeneration of plant populations at the on-set of the rainy season.

IX.16 Development of biodiversity information and monitoring systems – a case study from Germany

Begemann, F., Roscher, S.

German Centre for Documentation and Information in Agriculture (ZADI), Information Centre Genetic Resources (IGR)

The conservation and sustainable use of biodiversity as well as the equitable sharing of arising from the use of genetic resources is crucial for further human development. These principles have to be agreed upon since the 'Convention on Biological Diversity' (CBD). To come up with the task of sustainable use and conservation easy access to complex information on biodiversity is strongly needed. Biodiversity related information systems have to extend over ecosystems, species and the genetic level. Information about wild and domesticated species has to be covered, also ex-situ and in-situ data have to be interlinked. Knowledge in the field of bioinformatics as well as experience in the development of databases for ex-situ conservation of genetic resources is available nowadays. Also progress has been made in environmental information systems. But there is a gap in integrated information about species, genes and ecosystems and a possibility for the combination with socioeconomic data. To come up with the long term in-situ conservation of biodiversity the taken measurements have to be evaluated and the outcoming results have to be compared to the defined objectives. Concepts for reserve planning and establishment, and monitoring programs have to be developed. To handle the necessary data information systems should include a clear object definition (inter alia a list of species, populations to be monitored) and a definition of the objectives including thresholds, the chosen parameters and a description of methods used for the taken measurements. Also a list of the reasons for endangering for each monitoring object (species, population) should be available. Results of site specific monitoring results must be combined to a complete picture showing the state of conservation for species and/or groups of species. As a case study from Germany the 'Bundesinformationssystem Genetische Ressourcen (BIG)' (Federal Information System on Genetic Resources) is shown. BIG integrates databases on the wild flora of Germany, collections of botanical gardens, accessions of the largest German genebank, the other genebanks as well as other relevant databases. These databases are provided by agencies of the Federal Ministries, by universities and other research institutions. The institutions agreed to pool their extensive online databases together and established BIG as a mediated search mechanism, including search agents, knowledge base and thesaurus. The thesaurus is structured in three main parts taxonomy/nomenclature, other descriptors (technical terms) and gazetteer (geographical data). Based on this thesaurus combined searches for species name, related qualities and distribution are possible.

IX.17 Hypsometrischer Wandel der Biodiversität eines naturnahen Bergregenwaldes (Cotapata, Bolivien) in Abhängigkeit von Boden und Klima

Bach, K.¹, Schawe, M.²

1 University Göttingen, Department Systematic Botany, Untere Karspüle 2, D-37073 Göttingen (bach.kerstin@gmx.net). 2 University Göttingen, Department Landscape Ecology, Goldschmidtstr. 5, D-37077 Göttingen.

In den Yungas Boliviens werden seit Frühjahr 2000 in einem Gemeinschaftsprojekt der Abt. Landschaftsökologie und Systematische Botanik der Universität Göttingen und dem "Instituto de Ecología" La Paz geobotanische Untersuchungen zu Klima, Vegetation und Boden durchgeführt. Die Untersuchungen sind Bestandteil des DFG-Projektes "Hypsometrischer Wandel naturnaher Bergregenwaldökosysteme in den Yungas Boliviens". Das Untersuchungsgebiet im Nationalpark Cotapata mit naturnahen Bergregenwaldökosystemen ist durch sehr steile Hänge und einheitliches Ausgangssubstrat gekennzeichnet. Es konnten drei Höhen transekte in SE-Exposition zwischen 1600m und 3400m untersucht werden. Neben der kontinuierlichen Klimadatenerfassung (3 komplexe Basisstationen) wurden die Böden und die Vegetationsverteilung je 50-100m Höhendifferenz entlang der Transekte aufgezeichnet und ermöglichen so einen direkten Vergleich. Die Böden wurden profilmorphologisch erfaßt und die ausdifferenzierten Leitprofile laboranalytisch untersucht. Die Analysen umfassen pH, KAKeff., pedogene Oxide, Ct, Nt, Totalelementgehalt, Mikronährstoffe, Textur und Lagerungsdichte. Die Vegetationsaufnahmen wurden auf Basis von Indikatorgruppen (Pteridophyta, Araceae, Bromeliaceae, Melastomataceae, Palmae und Cactaceae; Kessler & Bach 1999) erfaßt. Ein Ziel des interdisziplinären Projekts ist der Nachweis hypsometrisch gesteuerter Prozesse mit Konsequenzen für die Biodiversität in Abhängigkeit von Boden und Klima in einem vollhumiden tropischen Klima (Jahresniederschlag 2500 - 3500 mm). In Anlehnung an die bisher wenigen Studien der humiden Andenostabdachung werden folgende Hypothesen verifiziert: Die thermisch-hygrische Höhenstufung bedingt über den Wasser- und Nährstoffumsatz eine entsprechende hypsometrische Biodiversität, Dominante bodenhydrologisch-bodenchemische Parameter korrelieren mit der Klima-Vegetationshöhenstufung. Die Analyse der Vegetationsaufnahmen differenziert drei verschiedene Waldtypen, mit einem Diversitätsmaximum in der montanen Stufe.

IX.18 Marine reserves and livelihood alternatives as successful approaches of coastal resource management in the philippines

Kühlmann, K.-J.

*Humboldt-University Berlin, Institute of Animal Sciences,
Philippstr.13, House 9, 10115 Berlin, Germany, (kuhlmann@rz.hu-berlin.de)*

In the past, inshore reefs (a vast and productive resource) provided the daily food sustenance of the rural coastal population in the Philippines through high catch of fish and invertebrate stocks. However, the rising socio-ecological conflict of low fish supply, degraded coastal environment and, the concomitant growing coastal population alarmingly demands an effective intervention. The Coastal Resource Management approach (CRM) deemed effective in pursuing the introduced scenario by considering complex interactions between local stakeholders, government and applied sciences of agriculture, aquaculture or marine biology. The present study introduces the CRM-approach as successful tool to rehabilitate degraded coastal environments, to alleviate poverty and to uplift socio-economic life of coastal populations in rural areas of the Philippines. By establishing and continuously monitoring marine reserves ("no-take-areas"), as one strategy, degraded reef areas may rehabilitate and contribute to the renewal of fish stocks through their emigration ("spill-over" effect) to nearby areas. Utilising the participatory approach technique, development and provision of sustainable livelihoods for the coastal populace are likely to decrease fishing pressure as well as to alleviate the socio-economic life. The marine reserves success would, however, require a responsible and concerted effort from the multi-sectoral stakeholders, such as the local coastal populace, organized socio-environmental groups and government units.

IX.19 Incentive measures to enhance sustainable use and conservaton of agrobiodiversity

Weiskopf, B.

Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, Dag-Hammarskjöld-Weg 1-5, 65760 Eschborn, Germany, (Beate.Weiskopf@gtz.de)

Agrobiodiversity has multiple functions and represents different values for farmers who plant and manage the agrobiodiversity and for human mankind in general. The possibilities of ex situ conservation to safe-guard agrobiodiversity that are threatened are limited, and are of little direct relevance for farmers who need genetic diversity for risk reduction and food security. Use of agrobiodiversity by farmers is a complementary, dynamic way of conservation. The workshop 'Incentive Measures for sustainable Use and Conservation of Agrobiodiversity' aims at identification of incentive measures and mechanisms for their operationalisation. The workshop concentrates on crop and animal genetic diversity and focuses on Sub Saharan Africa. For the workshop 5 fields of incentives are identified: policy, market, farmer-level, public awareness and education/training. Proceedings will be published on paper and electronically, and synthesis reports are planned for relevant newsletters. The workshop will be hosted by SPGRC and Ministry of Agriculture of Zambia, Plant and Animal Genetic Resources. The preparation is being carried out by a committee involving the hosting organisations, CTD (Community Technology Development Trust), GTZ, IPGRI and CTA. Funds are provided by SIDA, IDRC, GTZ, CTA and DSE. The poster will present the results of the workshop to be held on 11-14 September 2001 in Lusaka, Zambia.

Symposium X

Urban and Peri-Urban Production Systems

X.1 Research gaps create policy gaps: Killing two birds with one stone.

Nugent, R.

National Institutes of Health, U.S.A.

Cities and towns have always incorporated agriculture as part of their economic and livelihood activities. Agriculture has existed in many forms, including home gardens, intensive commercial enterprises, and as low-input, part-time farms on the periphery of cities. In the past two decades, globalization and urbanization have introduced new factors affecting agriculture's presence in and around cities. Among these factors are encroachment of urban development into productive agricultural land, migration from rural areas of agrarian workers and households, increased importance of international markets to developing country farmers, and vulnerability of both rural and urban households to global price and production trends. Simultaneously, nutrition and demographic transitions are affecting societies in ways that place demands on agriculture. Urban and peri-urban agricultural can meet many needs of food consumers in tropical zones, particularly by providing fresh horticultural products that fulfill dietary needs better than packaged, processed foods found in city supermarkets. Further, urban and peri-urban agriculture can contribute to the ecological sustainability of cities by recycling water and organic waste materials into food production. Finally, urban and peri-urban agriculture provides opportunities for social cohesion, recreation, and cultural and dietary continuity for new migrants to cities. All of these contributions depend upon an improved understanding of the risks and benefits of urban and peri-urban production to human health, environmental health, and social and economic structure. Additional research using sound methodologies, uniform definitions, and verifiable and credible data is desperately needed. Until then, sensible and beneficial local and national policies affecting urban and peri-urban agriculture will be an elusive goal. The keynote talk presents suggested methods for evaluating the sustainability of urban and peri-urban agriculture, a description of production and consumption trends that will affect the potential for sustainability, and an institutional agenda for accomplishing these objectives, incorporating both research and policy needs.

X.2 Composted Household Waste for Plant Protection in Peri-urban agriculture in five West African towns

Streiffeler, F., Kessler, A.

Humboldt-Universität zu Berlin

In West African cities and towns like Dakar, Lome, Ts,vi,, Conakry and Timbi MadCEna we observe different production systems depending on land tenure, water availability and market. Peri-urban cash-crop farmers use a lot of inputs, fertilisers the same way as pesticides. For soil fertility reasons they cultivate dumping places. The night soil from dumping places is even commercialised. Droppings from industrial animal husbandry and organic industrial wastes (i.e. oil cake from cotton seeds) are valorised as fertiliser. They are available on the organic fertiliser market for transport costs and that's why they are cheaper as controlled composted household waste. We observe a high awareness for pests 76 - 93 % depending on the production system. The awareness for diseases is lower 65 - 77 %. Even as rain fed farmers are aware of pests and diseases they treat them rarely. In the opposite all vegetable farmers of Lome use plant protection products. Vegetable farmers of Lome loose 55 % (onion) to 71 % (lettuce) in the average due to pests and diseases of the selling price. Even as vegetable farmers use a lot of plant protection products some of them have difficulties to differ between pests and diseases. Most of the vegetable farmers don't have specific vocabulary to differ the different insects or the different diseases. Only well trained vegetable farmers close to Dakar may know whether a disease is caused by fungi or virus or bacteria or others. Composted household waste can be used for plant protection against fungi. As fungicides are more expensive than organic fertilisers compost can concurrence fungicides. However extension is needed to differ diseases and how to use compost against fungi. Right now we have a very small market for phytosanitary compost. Some peri-urbain farmers are award that chemical plant protection products causes poisoning for them and their employees. Therefore biological plant protection is of several interests not just for the consumers of the agricultural products and their farmers but also for the cleanness of the cities. Anyway phytosanitary compost is produced in controlled conditions to avoid spreading of diseases which might by in the waste.

X.3 Beyond Urban Agriculture: Cities and Sustainable Development

Korff H.R.

Josef G. Knoll, Stiftungsgastprofessor, University of Hohenheim

Cities are highly heterogeneous concentrations of people and activities. As such they depend on the integration into networks reaching from a neighbourhood level, to urban peripheries, the country and even to global networks. As much as cities depend on such networks, the integration of larger regions depends on the integrative capacity of cities. In this regard cities depend on a city system incorporating urban rural relations, and these systems as well as relations are integrated through the cities. For population concentrations like cities networks through which food is supplied to the urban population have particular relevance. Urban agriculture has to be seen as one aspect of urban food supply related to other networks like the market economy, informal sector etc. Food supply of a city is not based on one network or one pattern of exchange, but characteristic is the co-existence of highly diverse linkages like forms of social exchange between neighbours and relatives, informal sector relations, a formalized market economy, or state organized networks. The heterogeneity of the city implies a heterogeneity of co-existing networks and relations. Through these interdependencies between city and agricultural areas (which can be located within the city or its fringe, but as well far away), urban and rural developmental dynamics are concomitant with each other and engender their own dynamic of change. The urban - rural linkages can have a "parasitic" character but might as well be "generative" for overall development. The thesis is that sustainable development is based on the integration and articulation of agricultural (mainly rural) and non-agricultural (mainly urban) regions and, more important, people and their activities. A disarticulation of rural and urban areas leads, in contrast, to fragmentation and a rapid deterioration of living conditions. The presentation will focus in a first part on general data on urban and agricultural development to indicate in how far development and underdevelopment are linked to the articulation between city and countryside. In a second part the general argument will be specified based on data from Thailand.

X.4 Nitrate concentrations in tomato and cauliflower petiole sap as affected by waste compost and inorganic fertilization in urban horticulture under tropical lowland conditions

Trüggelmann, L., Schnitzler, W.H.

*Chair of Vegetable Science, Crop Physiology and Quality Research,
TU München-Weihenstephan, Dürnast II, 85350 Freising-
Weihenstephan, Germany. (whs@vegetable.de)*

The impacts of market waste compost (MWC) and inorganic NP fertilization on nitrate concentrations in petiole press sap were evaluated in a vegetable rotation (tomato-cauliflower-tomato) from May 1999 to May 2000. The field experiments were conducted on a clay to clay loam soil under the humid tropical lowland conditions of Cagayan de Oro City, Mindanao, Philippines. In a two factorial randomized block design, eight different amounts and ratios of inorganic N and P fertilizers were combined with three different levels of MWC, a standard application of chicken manure (CM) and an unamended control treatment. Petiole samples for press sap nitrate analysis were taken during the first cropping of tomato (*Lycopersicon esculentum* Mill.) at 38, 48, 59, 70 and 80 days after transplanting (DAT). The subsequent cauliflower (*Brassica oleracea* L. var. *botrytis* L.) crop was sampled at 30 and 39 DAT. The last tomato crop was sampled in weekly intervals starting at 29 DAT. Nitrate contents in tomato petiole sap were in general lower than for comparable treatments of other studies under tropical upland conditions. Inorganic N fertilization rates correlated significantly (T-test, $p > 1\%$) with petiole nitrate concentrations at 48, 59 and 80 DAT ($r = 0.82$, 0.47 and 0.41) during the first tomato crop. This relation was also significant for cauliflower at both sampling dates (0.64 and 0.67). Except for the first sample at 29 DAT, a similar observation was made during the second tomato crop, with correlation coefficients ranging between 0.60 and 0.90 . During all croppings, there was no indication for a comparable relation due to MWC and CM applications. Yield and fruit number correlated significantly with nitrate concentrations in petiole press sap only at 48 DAT (0.58 and 0.64) during the first tomato crop. For the second tomato crop the correlation between petiole nitrate content from 36 to 100 DAT correlated significantly with yield ($0.51 < r > 0.74$) and fruit number ($0.53 < r > 0.81$). At both sampling dates petiole nitrate concentrations were significantly related with cauliflower biomass production (0.84 and 0.68) and total (0.82 and 0.68) as well as marketable curd yields (0.74 and 0.75).

X.5 Urban Vegetable Production in Dar es Salaam (Tanzania) - GIS-supported Analysis of Spatial Changes from 1992 to 1999

Dongus, S.

*University of Freiburg, Institute of Physical Geography
(dongus@gmx.de)*

By the year 2010 half of Tanzania's population will live in cities, with Dar es Salaam being the most important centre of all (population: 3 million people in 1999; annual growth: 8%). Involvement in the informal sector has become a strategy of survival for vulnerable groups like unemployed people, low wage earners, and women without sufficient skills to get well paid jobs. Urban agriculture is practised by a large number of residents, because it can offer employment, income and food security for the urban farmers and their families. Market production of vegetables in Dar es Salaam is taking place on private and public open spaces all around the city, in many cases illegally. In the past, only estimations were available about the extent of agricultural open spaces in the urban areas of Dar es Salaam. Therefore, a more scientific approach was chosen to close this knowledge gap and provide decision-makers in the city with more accurate data. By analysis of aerial photographs, field control, and application of Geographical Information Systems (GIS), a full inventory of agricultural open spaces including their locations and sizes was created for the years 1992 and 1999, visualised in a map, and is now available for planning purposes. Almost 650 ha of the urban area of Dar es Salaam are currently used for vegetable production on open spaces, which is equivalent to 4% of the whole surveyed area, offering employment for over 4000 farmers. 12% of these 650 ha are privately owned land, 48% are institutionally and 40% publicly owned. Caused by growing pressure on the land through increasing population, the general tendency is a reduction of the area used for open space production. Over 200 ha of agricultural open spaces vanished during the last seven years. But despite this pressure, 120 ha newly emerged. This shows the viability of urban agriculture as one of the survival strategies for the urban poor and is an indication for the importance and function of open space production in the urban area of Dar es Salaam.

X.6 Urban agriculture in the third millennium

Madaleno, I.M.

*Instituto de Investigação Científica Tropical, Sítio do Carrascal,
Tapada da Ajuda, Apartado 3014, 1301 Lisboa Codex, Portugal.
(isabel-madaleno@clix.pt)*

How will the cities of the future look like? It was always a passionate task to imagine the future of urban settlements, closely followed by utopic drawings and visions of ideal cities. There are countless projects of urban planning, devised by the most illuminated visionaries, ranging from cities multiplied in height, subterranean cities ideal for desert climates, or floating cities in highly densely riverine populated areas, etc. Some of these projects are simply spectacular, others science fiction in action, and far too many are garden cities, spaces where human beings can be happily associated with nature. Urban agriculture, defined as food and non-food production dispersed throughout urban and peri-urban areas, will certainly play an important role and occupy a considerable space and people in the cities of the future. The main benefits of these activities will be the improvement of nutritional health of the urbanites, which in developing countries is more likely to be a synonym with food self-reliance, jobs and survival strategies; urban agriculture will also give the opportunity for purposeful recreation and educate the youngsters on health and environmental issues; urban agriculture will help to develop community bonds, even when it is practiced by families or on an individual basis, because it intensifies cooperation between people and the sense of share; urban agriculture will constitute the best solution to ameliorate the urban environment, once it enhances a wide range of benefits one can take away from public open spaces.

X.7 Effective use of urine in peri-urban systems

Clemens, J.

Institute of Agricultural Chemistry, University of Bonn, Karlrobert-Kreiten-Strasse 13, D 53115 Bonn, a.clemens@uni-bonn.de

Food production around cities in peri-urban wetlands plays a major role in the food supply of the city's population. But the high costs of mineral fertilizer limit the productivity. One major input of fertilizers has been faeces from humans. Their „conventional“ use, this is the direct use in the fields, has some major disadvantages: Firstly, potential pathogens may contaminate the food. Secondly, the nutrient supply by organic fertilizer and the plant's demand for nutrients frequently do not coincide. Thirdly, major nutrient losses may occur, esp. nitrogen. Urine, as the most relevant source of nutrients in faeces, may be used in a more efficient way. We developed a system that preserves the N, P and K in the liquid but also eliminates pathogens in a cost effective way. The modified urine may replace mineral fertilizers. At the moment we plan an investigation on the feasibility of such a system in terms of acceptance, technical and financial frames and nutrient efficiency of the substrate.

X.8 Supply Chain of Foods and their application in the Metropolitan Park of Havana

Suárez, J.A.A.¹, Acosta, M.G.¹, Rodríguez, A.J.U.¹,
Acosta, L.¹, Röhrich, K.², Schulze, W.-K.²

ISPJAE, Cuba. IASP, Germany

The development of food production, the protection of environment and the increase in competitiveness of food companies is a strategic key activity in Cuba's policy for the development of the country. In this context the DAAD funds a co-operation project, initiated from IASP and ISPJA with the objective to develop a framework for sustainable food production in the Metropolitan Park of Havana. The research outcomes support the hypothesis that the three above mentioned strategic objectives can be achieved by the implementation of an integral food supply chain including any activity from soil treatment and sowings to consumption of foods. The main objectives of this integrated approach are: minimum contamination, conservation and improvement of land, integral use of the materials, recycling/upgrading of waste products, more stable supply of foods, reduction of costs; increase of the added value contributed the consumer; contribution to the solution of the social problems of the environment; maximum quality of the final products. The application of these principles to the given geographical, economic and social environment of the Metropolitan Park of Havana demands innovative technologies. For this purpose specific analytical methods have been developed as well as an general organisational model, allowing an integral analysis of the food supply chain based on the material, information and financial flows within the supply chain. This analysis was applied to the agricultural co-operatives of the Metropolitan Park. The results show that the implementation of industrial production and processing methods already for a relatively small range of agricultural products contributes to an substantial reduction of losses and increase in productivity. On the other hand, industrial production methods favour new cultivation technologies, improvements with respect to packaging and transports, upgrading of waste products, implementation of systems for quality assurance as well as possibilities for marketing, ecological tourism, habitation and leisure time activities for the inhabitants of the Metropolitan Park. Altogether the project outcomes contribute to a sustainable production of foods including environmental, economic and social aspects of the Metropolitan Park of Havana.

X.9 Urban and peri urban agriculture in lima

Dasso, J.A.

*Asociacion Recursos para el Desarrollo – REDE, P.O Box. 18-0947
Lima 18. Peru, (rede@amauta.rcp.net.pe)*

Since the 80s in Peru, Urban Agriculture has been increasing and has taken more importance for the interventions projects in the field of Nutrition and Food Security, also for income generation activities among the poor people living at marginal areas; but there is other agricultural experience around Lima that is having more importance in these day, and provides food to the city, this is the Peri Urban Agriculture. On other hand Peri Urban Agriculture is not considered by the data of national agriculture production and has a high potential to provide food to the city. The poster is presenting this two different: case studies photos and legends for production systems of each one: a) Interventions in Urban Agriculture for Marginal Urban. Skills: Social Program Nutrition and health Programs Relief and mitigation, non permanent work just partial, voluntary Stakeholders: Ngos, Public Sector- Program Poverty Alleviation Autoconsumption, subsistence and approaches to the daily diet Community participation Products: Vegetable production and animal production, food processing b) Experience of farmers at the Peri-Urban Area Spontaneous background and different systems of production Scope of view: Commercial potential, small, mid and high business, permanent work, family job, and enterprises. Stakeholders: Farmers, investors and city planners.

X.10 The Role of NGOs and CBOs in Agricultural Marketing in Uganda

Hartwich, F., Gordon, A.

Social & Economic Development Department, Natural Resources Institute (NRI), University of Greenwich, Central Avenue, Chatham Maritime, Kent ME4 4TB, United Kingdom, (f.hartwich@gre.ac.uk).

Involvement of producer organisations in marketing of farm products has a long tradition. In many developing countries governments through marketing boards and often an imposed co-operative system have aimed to vitalize marketing of agricultural products - with mixed success. However, governments have recently liberalized markets and removed marketing boards creating more opportunity for private and local initiatives. In consequence also many international and local NGOs become involved in agricultural marketing. They involve in a spectrum of measures ranging from training to of farmers and middlemen to active buying and selling on the market. Drawing from the theory of public/private good it can be argued that some of those initiatives lead to unintentional market distortion and lack sustainability. The paper reviews involvement of NGOs in agricultural marketing in Uganda. It draws from preliminary results of research funded by DFID and carried out by the Natural Resources Institute (NRI), UK, and the Government of Uganda through its National Agricultural Advisory Services (NAADS). The research aims to identify and develop commercially sustainable and replicable NGO/CBO agricultural marketing and processing interventions, which improve poor farmers' livelihoods. The paper first outlines the public/private good theory, focusing particularly on market failure in rural services and agricultural marketing. It then gives an overview of domestic crop marketing in Uganda and describes a number of related NGO initiatives. Rapid reconnaissance methods are used for diagnosing sub-sector limitations and delineating respective marketing initiatives of NGOs. The paper concludes with proposing and discussing best practice option.

X.11 Some Issues of Land Ownership and Land Market Development in Armenia

Khachatryan, A., Khachatryan, N.

University of Hohenheim, Department of Agricultural Economics and Social Sciences (490C), Frühwirthstr. 12, 70599 Stuttgart, Germany, (armen@uni-hohenheim.de).

On the policy front, Armenia has implemented one of the most comprehensive land reform programs in the FSU Republics. By the end of 1992, most of the agricultural land had been privatised, with over 300,000 individual farms formed in the process. After almost a decade of the collapse of the planned economy Armenian agriculture is still characterized by the dominance of small, subsistence farms, small production of many types of different crops, dependence on foreign raw materials and limited financial assistance (if any) and limited credit access, and the general approach of aiming to just providing basic needs of their families. Traditional small farming communities chiefly geared to food security and conservation of natural raw materials are facing a crisis situation. Efforts to establish land market show little progress. Though the peasant farmers basically have ownership rights on the farmland, the uneven pace of reform across sectors, fluctuating progress in stabilization, frequent changes in counterpart ministries, constitutional uncertainties, the strong role of local governments, etc., have made the task all the more difficult. The paper identifies the problems related to the development of land market and discusses the reasons behind the failure to establish mechanisms for farmers allowing them effectively exercise their ownership rights.

Symposium XI

Animal Production Systems

XI.1 Demographic and ecological challenges to livestock production systems in semi-arid and sub-humid regions of Africa

Schlecht, E.

*Institute for Animal Production in the Tropics and Subtropics,
University of Hohenheim, D-70593 Stuttgart, Germany, (eset@uni-
hohenheim.de).*

The presentation concentrates on mobile pastoral systems, mixed crop-livestock farming and urban and peri-urban livestock enterprises, the three major livestock husbandry systems to be found in semi-arid and sub-humid zones of West and Central Africa. Reviewing the changes in agricultural and livestock husbandry practices that occurred since the mid-1970ies, and taking into account the consequences of the rapid demographic growth and increasing urbanisation, the current agro-ecological and socio-economic conditions for these systems are discussed. Central issues are the increasing competition for cropland and pastures between the three systems, the increasing privatisation of common fodder resources, the limited infrastructure and market access in many rural areas, the unbalanced nutrient flux towards urban centres and the ecological consequences and sanitary risks arising from this. Crucial questions are: - How can the complementary role between mobile livestock systems and mixed crop-livestock farming be strengthened and how can these systems increase their supply of livestock products without (further) detriment to the environment? - Can the demand for animal feed and other inputs to urban livestock enterprises be satisfied and might it induce a clear-cut shift in the orientation of rural production systems? - How will the urban population and the nutrient supplying hinterland be affected by the concentration of nutrients / animal wastes in urban areas? - What economic consequences will evolve from growing urban livestock enterprises, for the consumers as well as for rural livestock producers?

XI.2 Valuation of performance of indigenious chicken types in Ethiopia

Tadelle, .D.¹, Million, T.², Alemu, Y.², Peters, K.J.¹

1 Humboldt University of Berlin, Animal Breeding for Tropics and sub-tropics, Philippstr. 13, Haus 9, 10115 Berlin, (sarmeder@hotmail.com). 2 Debre Zeit Agriculture Research Centre, P.O.Box 32, Debre Zeit, Ethiopia

This study was conducted in 250 HHs of five different agro-ecological regions (two market sheds from each region) of Ethiopia. The objectives were to value local chicken types, understanding the breeding objectives and selection criteria's of farmers under village production conditions. A formal survey, using a structured questionnaire integrated with Participatory Rural Appraisal (PRA) techniques relevant to rural chicken production was applied. In addition, a recall survey was conducted to establish hen performance history in 10 households from each of the 10 study villages. The chicken production system in all the study regions was characterised by its low input-output level. Scavenging Feed Resource Base (SFRB) was reported to be the major source of feed for the birds. Average N of birds/household was 7.4 ± 3.6 mature birds. Mean egg numbers per clutch were 15.7, 19.6 and 21.3 eggs for the first, second and third and above clutches, respectively with a mean clutch number of 2.5 ± 0.8 per year. The mean number of eggs set per bird was 13.1 ± 7 . The hatching rate was $70 \pm 10.6\%$ ranging from 30-90% (n=250) with an average survival rate of 51.3 ± 10.6 , ranging from 30-90. Based on the results of this study, indigenious chicken have economic or direct (sale, consumption, reproduction and manure) values, and non-economic or indirect (social and religious functions, cleaning the environment, tick control, optional and existence and bequest) values. As to the direct values, reproduction, sale and consumption were the main breeding objectives of households from all the study regions in their orders of importance. The cultural, social and religious functions of indigenious chicken types were important in all the study sites. Productivity, size of the eggs, conformation of the mother bird and information from relatives, neighbours etc were reported to be used as selection criteria by farm households for selection of replacement stock, in addition to the colour and comb type for social and religious functions. >From the results of this study, it is possible to conclude that the indigenious chicken types in the different agro-ecological regions have not been shaped only by the environment but also by human intervention. The total values of chicken is certainly composed of the direct economic and indirect cultural/religious value but the latter is difficult to assess in monetary terms.

XI.3 Characterization of Goat Production Systems in the Interandean Valleys of Bolivia

Altug, T.¹, Valle Zárate, A.¹, Stemmer, A.²

1 Institut für Tierproduktion in den Tropen und Subtropen, Universität Hohenheim, Stuttgart, Germany, (turaltug@uni-hohenheim.de). 2 Facultad de Ciencias Agrícolas y Pecuarias, Universidad Mayor de San Simón, Cochabamba, Bolivia

The objective of this study was the evaluation of goat production systems by using different aspects and to describe the genetic resource "Criollo-goat"; it is part of a complex investigation on livelihood and farming systems, which is essential for the development of future breeding strategies for goats in the study area. The study was carried out between January 1999 and March 2000 in the province Mizque (2,000-3,100 m asl) of the Dept. Cochabamba in Bolivia. In 8 communities 42 goat-keeping households were selected. The methods applied were: performance recording of animals, participant observation, unstructured interviews and questionnaires. Average number of persons belonging to one household was 5.4 (1.9). The majority of heads of households were male. 54.8% of female and 28.9% of male adults have not received any schooling. The majority (57.1%) of households had 0.6-2.0 ha of land to cultivate. Potato, maize, wheat and vegetables were dominant products dependent on location of communities. Most respondents (95.2%) kept goats together with sheep. The mean flock size for goats was 22.1 (16.9 does and 4.0 (3.2 bucks). The main reason given for keeping goats was production of manure (94.7%). Goats were kept together with sheep all year round in corrals without any roofs. Goats were grazed in 47.6% of the cases on communal pastures. Goat milk was the only kind of milk for small holders especially in communities situated in the Pampa. Goats were milked in the rainy season between November and March depending on the abundance of vegetation on the pasture. The responsibility for the small ruminants was shared by mothers and children of households. Monetary investments into goat production were unusual. Major problems of goat keeping as indicated by farmers were malnutrition (47.4%), diseases (36.8%) and predators (13.2%). Farmers sold or exchanged goats, when they needed cash or other commodities. If households would have investment options, almost all of them stated to like to extend goat husbandry to achieve more manure, milk and meat. Two third of the smallholder households would like to buy irrigated land and milk animals if they would have money available for investment.

XI.4 Utilization of activated charcoal in feeding management of indigenous goat (Ettawa Crossbreed Goats)

Bachrudin, Z., Hastuti, S., Silvia, F., Nurwiyanti, Hidayati, S., Wahyudi, L.

Faculty of Animal Sciences, Gadjah Mada University, Agro Karang malang. 55281, Yogyakarta. Indonesia.

The objective of this study was to determine the utilization of activated charcoal (AC) as feed additive in the ration on the fermentation type of the ruminal fluid, the N balance and the performance of Crossbreed Goats (ECG). Nine of ECG with same age was divided into 3 groups randomly: Group I (R1); Group II (R2) and Group III (R3) had been fed a ration with different of AC contents were 0.0 %; 0.3 % and 0.6 % of dry matter (DM) requirement respectively. Each group had 3 animals as replications. All animals were fed which contain of 30% peanut straw as forage sources and 70% concentrate. While the concentrate contain Digestible Energy (DE) 3.2 Cal/Kg DM and crude protein (CP) 12.0%. The compose of the concentrate was corn, rice brand and soybean meal. This experiments was conducted in 3 periods: First period had 15 days for pra adaptation; Second period had 15 days for adaptation and Third period had 40 days for biological evaluation. The collected variables were the pH and cellulase and amylase activity of rumen fluid, the balance of Nitrogen and average daily gain (ADG). The result of study showed that there is no significantly different between AC additions on the pH rumen of fluid of the goats, however the AC addition improve the activity of cellulase and amylase of the rumen fluid ($P < 0.1$). The amount of DM intake, N intake and % N urine of N intake ration and N balance for R1, RII and RIII are 39.76; 40.98; and 49.94 g/Kg BW^{0.75}/day; 0.70; 0.74 and 0.98 g/Kg BW^{0.75}/day, 52.12; 40.27 and 35.93% and 0.165; 0.262; 0.412 g/KG BW^{0.75}/day respectively. The AC addition didn't affect on ADG and feed conversion, but the 0.6% AC addition increase the feed consumption ($P < .05$). This study can be concluded that AC addition enhanced the scarification in the rumen and the value of N balance of ECG.

XI.5 A survey of nutritional and antinutritional properties of major ruminant feed resources in semi-arid West Africa

Hoffmann, E.¹, Muetzel, S.¹, Becker, K.¹, Akinbamijo, O.O.²

1 University of Hohenheim, Stuttgart, Germany. 2 International Trypanotolerance Centre, Banjul, The Gambia

Ruminant nutrition in The Gambia, West Africa, relies largely on agricultural by-products such as cereal straws, groundnut hay, or horticultural residues. Feed evaluation of these materials has so far been based mostly on crude nutrient composition. Reports on systematic in vivo or in vitro trials are scarce, and information on antinutritive components, especially on the tannin content of feed resources is not available at all. Therefore we present a comparative analysis of 18 samples identified as important feed resources for ruminants in The Gambia with a focus on in vitro gas production (Hohenheim Gas Test), and tannin content. A differentiated and detailed analysis of tannins was made to distinguish between total phenols determined by Folin- or Ferric Chloride assay, total tannins determined by BSA precipitation, and condensed tannins determined by Butanol-HCl assay. The results illustrate that feed evaluation using one or just a few analytical parameters can be misleading. They underline the usefulness of in vitro systems for feed evaluation, and they fill a gap in the description of the regional feed resources. As part of a cooperative research project between the University of Hohenheim, Germany, and the International Trypanotolerance Centre, The Gambia, the data will be used to formulate a tannin free basic diet for cattle adapted to tropical conditions. Supplementation of the basic diet with tannins from various, clearly defined sources will then allow us to study the effects of these compounds on ruminal fermentation.

XI.6 Ecological and strategic endoparasite controlling in ruminants in tropical south america

Suárez, V., Tawfik, E.S.

*Dept. of International Animal Husbandry, University of Kassel,
Steinstrasse 19, 37213 Witzenhausen*

The control of parasites in one district must not be used in other places. A study of the populations' dynamics of various parasite species in each region and production system is necessary. A basic schematic and integral control includes actions in relationship with the host (strategic treatment against parasites) and with the environment (forage area hygiene, drainage, animal density, etc.). The principal alternatives for this kind of control are: Hygiene of the forage area and the application of substances against parasites. The application of hygiene measures on the grass is very important for the control of parasites, because many stages of its lifecycle take place temporally on the ground. Basically the measures to prepare a secure pasture are to avoid animals becoming infected or that the same ground is used for animals that have already been treated against parasites. Utilization of resistant hosts as a chance to control parasites The utilization of resistant hosts in order to control the parasite sickness is to do with the selection of resistant breeds or individuals resistant within the herd. Breeds from *Bos indicus* are less susceptible to parasites than *Bos taurus*. Because a genetic variation exists, it permits the incorporation of new characteristics in genetic selection programs. The first condition to incorporate a new genetic characteristic for genetic selection is the control as an answer to this selection. Biological control. The biological control of parasites is continuously under research. The utilization of some fungi species like *D. flagrans* causes the destruction of parasite larvae with the following mechanisms: catching the parasite larvae through adhesive nets or points and constriction rings. This fungi can also penetrate the spores, the cuticle and the digestive tube of the larvae (RODRIGUEZ 1992). Chemical control. This should take place in the case of ticks in the period of the year where the number of parasites is higher than animals. Internal parasitism and de-worming of sheep and cattle with chemical products must be carried out in a strategic way, especially in the rainy season.

XI.7 Tropical wood-decaying fungi as a means of conversion of agricultural plant residues: Influence of the incubation temperature on the activities of ligninolytic enzymes

Permana, I.G.¹, in der Wiesche, C.², ter Meulen, U.³, Flachowsky, G.⁴, Zadrazil, F.²

1 Faculty of Animal Science, Bogor Agricultural University, Jl. Rasamala-Darmaga, Bogor, Indonesia. (permana@jpb.ac.id). 2 Institute of Plant Nutrition and Soil Science, Federal Agricultural Research Center, Braunschweig, Germany. 3 Institute of Animal Physiology and Animal Nutrition, Department of Tropical Animal Nutrition, Georg-August-University, Göttingen, Germany. 4 Institute of Animal Nutrition, Federal Agricultural Research Center, Braunschweig, Germany.

The aim of this work was to determine the influence of the incubation temperature on the production of extracellular ligninolytic enzymes and the degradation of lignocellulose by selected tropical fungi. Four tropical wood-decaying fungi, *Auricularia sp.*, *Coriolus versicolor*, *Lentinus edodes* and *Polyporus sp.* were grown on sterile wheat straw (25 g, particle size < 2mm, moistened with 75ml water) for five weeks at 18°C, 25°C or 30°C, respectively. The activities of extracellular ligninolytic enzymes (laccases and manganese peroxidases) were assessed weekly. In addition the substrates were analysed with regard to the in vitro digestibility, the loss of organic matter and lignin. Generally higher incubation temperature enhanced the colonization of the straw substrate by the fungal mycelium and the increase of enzymatic activities. Moreover the highest enzyme levels were usually found at 30°C. Only *L. edodes* displayed highest enzyme activities at 18°C or 25°C. Loss of organic matter and loss of lignin were highest at 30°C, with the exception of *L. edodes* (25°C temperature optimum). *C. versicolor* degraded more lignin compared to the other fungi tested (69% of initial after 5 weeks). High degradation of lignin and in vitro digestibility along with relatively low degradation of other straw components was performed by *Auricularia sp.* and *L. edodes* at 25°C, which makes these fungi seem promising with regard to selective delignification of plant waste materials.

XI.8 Evaluation of breed preferences and breeding practices in extensive livestock production systems - Results and methodology assessing farmers' perceptions on indigenous cattle breeds in The Gambia

Steglich, M.¹, Peters, K.-J²

1 International Trypanotolerance Centre, PMB 14, Banjul, The Gambia, (m.steglich@itc.gm). 2 Humboldt University of Berlin, Dep. of Animal Sciences, Livestock Breeding in the Tropics and Subtropics.

Despite severe ecological constraints, foremost the presence of trypanosomiasis, agro-pastoralists in humid and sub-humid West Africa have succeeded in establishing sustainable production systems in which livestock is of vital importance. In The Gambia, the N'Dama cattle breed is considered as a valuable animal genetic resource due to its tolerance to trypanosomiasis. Nevertheless, gradually altering production conditions pose a threat to the indigenous livestock populations and loss of adaptive traits due to crossbreeding with imported breeds is a major concern. Methodologies to identify agro-pastoralists' breed preferences and their interest into traits (production and functional) need to be further explored. A better understanding of farmers' breeding strategies will help to monitor changes in the indigenous cattle population and to support policy formulation targeting at sustainable private and public breed improvement and conservation efforts. Data describing farming systems, production objectives, breeding knowledge and practices is obtained through a survey carried out in three districts of The Gambia including 180 randomly selected agro-pastoralists. A matrix ranking technique provides information on breed preferences and importance of criteria that agro-pastoralists use to evaluate their cattle breeds. Preliminary results confirm strong preference for N'Dama cattle favoured for its 'disease resistance' and 'fitness'. Milk yield, reproductive performance, libido of the bulls, animal size and workability are also found to be important traits. Agro-pastoralists like Zebu-type cattle for their 'bigger size', 'strength' and 'superior productivity', but consider them unsuitable to keep, since they 'easily die'. Well-structured breeding strategies exist among agro-pastoralists. Performance of ancestors regarding milk yield is taken into account in selection decisions. In traditional production systems, the aim for large herd size still dominates breeding strategies. Factors such as availability of grazing land, water access and intensification of crop production affect breeding decisions and lead to crossbreeding N'Dama with neighbouring trypanosusceptible zebu-type cattle. The methodology applied in this study to assess and evaluate breed preferences and breeding practices is regarded an effective tool to gain a better understanding on breeding strategies related to extensive livestock production systems.

XI.9 Estimation of reliable breeding values for smallholder dairy production under unfavourable conditions in the tropics

Zumbach, B., Peters, K.-J.

*Humboldt-University Berlin, Dep. of Animal Breeding in the Tropics and Subtropics, Philippstr. 13, Haus 9, 10115 Berlin;
(birgit.zumbach@rz.hu-berlin.de)*

A considerable shift in milk production in (sub)tropical regions, where circumstances allow, can be achieved by crossbreeding local cattle breeds with exotics. After attuning the degree of gene proportion of local and exotic cattle to the local situations and breeding for some generations we can assume those cattle to form synthetic populations. To maintain or further increase milk production pure-breeding strategies have to be used. This also applies to situations where only local cattle can be held and to the other extreme where exotic pure-breds are profitable. Standard breeding strategies and programmes copied from developed countries have shown not to be suitable for (sub)tropical realities. Thus, sustainable breeding methods taking into account the specific problems of the (sub)tropics have to be developed. Genetic response implies selection and propagation of genetic superior animals. To find those animals, reliable breeding values of all candidates have to be estimated. The objective of this study is to suggest appropriate methods for breeding value estimation taking into account unfavourable structural and seasonal conditions prevailing in the (sub)tropics and thus allowing for genetic response. In this study the trait milk production will be considered. An ideal population with known parentage will be generated. Given the variance components, milk yield per test day will be generated for each cow. By simulation of typical (sub)tropical conditions, e.g. strong seasonal effects, small herd sizes, minimum prerequisites for an effective breeding value estimation are to be worked out.

XI.10 Using Cluster Analysis as a Methodology for prototyping Livestock Production Systems: A Case Study of the Haryana State, India

Saha, A.K.

Institut 490C, Department of Agricultural Economics and Social Sciences in the Tropics and Subtropics, Universität Hohenheim, 70599 Stuttgart, (amitsaha@uni-hohenheim.de)

There is an increasing importance of smallholder livestock production systems with milk as the major commodity in mixed farming systems. More than 90 percent of milk production is generated in mixed-farming systems. With the majority of livestock products such as milk coming from these smallholder labour intensive low input milk production systems, it is necessary to characterize and analyse these systems for future impact analysis and to determine the strategies for improvement. Under smallholder conditions, milk tends to be a more important output than meat. Though a lot of studies have been done to characterize the farming systems in different agro-climatic zones in India, not much has been done to characterize and represent the milk production systems. The present study identifies the milk production systems in the state of Haryana using cluster analysis. The milk production systems were further quantified and its parameters determined in terms of economic returns.

XI.11 Effect of breeding on different production parameters in wild pigs (*Sus scrofa*), crossbred pigs and Meishan pigs in Thailand

Chongkasikit, N.¹, Vearasilp, T.¹, ter Meulen, U.²

1 Department of Animal Nutrition, Chiang Mai University, 50200 Chiang Mai, Thailand. (agismkch@chiangmai.ac.th). 2 Institute of Animal Physiology and Animal Nutrition, Department of Tropical Animal Nutrition, Georg-August-University, Kellnerweg 6, 37077 Göttingen, Germany.

In Thailand a market for meat of wild pig (*Sus scrofa*) are developing. Simultaneously the number of *Sus scrofa* living in the wild are declining since the areas of natural habitat are reduced. On farm production of wild pigs is an alternative source for this meat and can serve as a genetic resource of wild pigs for future use. However, wild pig productivity expressed in terms of ADG, feed conversion rate (FCR), carcass quality and the number of piglets per litter is low as compared to Thai native pigs, European pig breeds and Meishan pigs though they are well adapted to the hot climate and probably resistant to some diseases in Thailand. In order to test if an increase in productive performance can be achieved by crossbreeding of wild pig with European pig breeds and Meishan pigs 15 wild boars were mated to 9 wild sows, 10 crossbred sows (75% wild pig: 25% Large White) and 5 Meishan sows. The litter size of Meishan pigs was with on average 8.8 piglets significantly ($P<0.05$) higher than of wild pigs (5.56). Birth weight (1.205 and 1.094 kg) and weaning weight (6.43 and 5.84 kg) of male and female piglets from wild pigs x Meishan pigs was significantly ($P<0.05$) higher than for wild pigs x crossbred pigs (0.98, 0.79, 5.50 and 5.14 kg respectively) and wild pigs x wild pigs (0.70, 0.64, 3.85 and 4.29 kg respectively). Body weight at 17 weeks of male and female piglets from wild pigs x Meishan pigs was with 29,0 kg and 21.5 kg significantly ($P<0.05$) higher than that of wild pigs x crossbred pig (16.10 and 15.48 kg). Pre weaning average daily gain (ADG) of male piglets from wild pigs x Meishan pigs and wild pigs x crossbred pigs was also significantly ($P<0.05$) higher than for wild pigs x wild pigs. The trial showed that a suitable crossbreeding programme can improve the productivity of the wild pigs.

XI.12 Impact of silage on livestock production systems in rain fed coastal areas of Morocco

El Housni, A.¹, Thinggaard, G.², ter Meulen, U.², Boulanouar, B.¹, Elhimdy, B.¹

1 National Institute of Agriculture Research (INRA), Rabat Institute, Rabat, Morocco. (inra_pvr@maghrebnet.net.ma). 2 Institute of Animal Physiology and Animal Nutrition, Department of Tropical Animal Nutrition, Georg-August-University, Kellnerweg 6, 37077 Göttingen, Germany.

Livestock production systems in Morocco varies but generally livestock feeding is based upon straw and fallow supplemented with concentrate. Forage contribution is low and highly variable (from 3 to 18% of energy intake). The feeding calendar is characterised by a lack of fresh forage from August to December, which some farmers have tried to overcome by making silage. In a survey conducted in the rain fed Atlantic coastal areas, all farmers with experience in silage making were questioned regarding their animal, crop production and their experiences with silage production and samples of silage were taken from all silos, with the objectives to get a clear picture of the present state of silage making in the area. A total of 54 farmers rearing cattle (94%) and/or sheep (79%) who had practised silage making for 1-38 years took part in the survey. Cattle farmers had on average 96 head of cattle and sheep farmers 313 animals. Crop production system was based on cereal (for grain) and forage. The proportion of land set apart for production of forage crops was 18.5%, largely exceeding the national ratio of forage land (10%). Silage was made from oat (74%), barley (15%) and Triticale (10%). 31% of the crop was harvested at a ripe stage and 9% at an earlier stage. Chemical analysis of silage samples from the area showed a crude protein content of approx. 10% and crude fibre of 25% on a dry matter basis. Most silage samples had a high butyric acid content indicating a clostridia fermentation. The average yield of ensiled crop was 3750 UF/ha compared to 1500 UF/ha yielded by oat harvested as hay. Therefore ensiling increased the energy yield. Forage conservation in the form of silage allows for livestock production intensification in the rain fed areas of coastal Morocco. The survey indicated a wide variation in silage quality within the areas and specific differences in livestock production among the surveyed farmers. Another outcome of the survey indicated that extension approaches and methods should be fields problems oriented.

XI.13 A comparative study in Thailand on carcass and meat quality in pig production based on increasing landrace lines

Jaturasitha, S.¹, Praharnripurab, W.¹, Pinpong, S.¹,
Rurksasen, P.¹, Kamopas, S.¹, Pichitpantapong, S.¹,
Wudthithumkanaporn, Y.¹, Thiravong, P.¹, Worachai, L.¹,
ter Meulen, U.², Veearasilp, T.¹

1 Department of Animal Nutrition, Chiang Mai University, 50200 Chiang Mai, Thailand. (agismkch@chiangmai.ac.th). 2 Institute of Animal Physiology and Animal Nutrition, Department of Tropical Animal Nutrition, Georg-August-University, Kellnerweg 6, 37077 Göttingen, Germany.

Duroc (D), Landrace (LR) and Large white (LW) are the common pig breeds commercially used in Thailand. This study was set up to evaluate if the LR could be used in crossbreeding programmes at levels higher than 25 % and up to 62.5 % without loss in performance. Fourteen finishing crossbred (D x (LR x LW)) pigs at 50:25:25 and 26 finishing crossbred (LR x (D x (LR x LW))) pigs at 25:62.5:12.5 were offered the same feed from 30 kg for 110 days under the same management conditions. The carcass traits were examined after slaughtering. The carcass weight of pigs with 62.5 % LR were significantly ($P<0.05$) higher than the pigs with 25 % LR (84.21 vs 78.48 kg). Weight significantly ($P<0.05$) affected the dressing percentage (73.46 vs 73.02 %, respectively) but there were no significant ($P>0.05$) differences in carcass length, loin eye area, back fat thickness and lean meat percentage. Meat quality traits in terms of redness (a^*) of 62.5 % LR was significantly ($P<0.05$) higher than of 25 % LR and higher a^* -value was associated with darker meat. There were no significant differences ($P>0.05$) in such direct meat quality traits as water losses and shear force value. The 62.5 % LR tended to have slightly favourable carcass traits and meat quality compared to the 12.5 % LR. From a meat production perspective, LR can be included in cross-breeding programmes at 62.5 % with D and LW.

XI.14 Effects of some factors on mummification in pigs in Thailand

Phongphaew, A.¹, Udomsri, K.¹, Vearasilp, T.¹, ter Meulen, U.²

1 Department of Animal Nutrition, Chiang Mai University, 50200 Chiang Mai, Thailand. (agismkch@chiangmai.ac.th). 2 Institute of Animal Physiology and Animal Nutrition, Department of Tropical Animal Nutrition, Georg-August-University, Kellnerweg 6, 37077 Göttingen, Germany.

Data of 109 gilts and 351 sows at the Animal Science Farm, Chiangmai University, Thailand were analysed in order to study the effects of parity, breed and climate on mummification in pigs. The results indicated no correlation between litter size and mummification rates whereas parities and breeds ($p < 0.05$) influenced this rate. The highest percentage of mummified pigs (7.1%) occurred in gilt and differed significantly ($p < 0.05$) from the results of sows in parities 2 and 3 but not significantly from results of sows in parities 4 to 9. Among breeds the prevalence of 8.8% found in pure bred Duroc (D) was considerably different from results by pure bred Landrace (L) and pure bred Large White (LW) but no difference was found between LW×D and LW×L ($p > 0.05$). Analysis indicated no climatic effect since the average number of mummified pigs per month within a year was not statistical different ($p > 0.5$). However, occurrence of mummification rate in summer (5.0%) and rainy season (4.9%) tended to be higher than in winter (3.8%).

XI.15 Response of young cattle feed rice straw and cassava foliage to a single drench of cooking oil, in Cambodia

Seng, M.^{1,2,3}, Preston, T.R.², Leng, R.A.², ter Meulen, U.³

1 Royal University of Agriculture, P.O.Box 2696, Phnom Penh, Cambodia. (mseng@hotmail.com). 2 University of Tropical Agriculture Foundation, Phnom Penh, Cambodia. 3 Institute of Animal Physiology and Animal Nutrition, Department of Tropical Animal Nutrition, Georg-August-University, Kellnerweg 6, 37077 Göttingen, Germany.

The following study is an attempt to improve the utilization of available resources and develop a system for fattening local cattle in Cambodia. It is based on two principles: Ruminants use their feed more efficiently when protozoa are absent from the rumen and cassava foliage has been found to be a source of by-pass protein for ruminants. Twelve growing local "Yellow" cattle of 114 kg (SE \pm 4.35), received a basal diet of ad libitum rice straw and a rumen supplement (15% urea) at 300g/head/day. The 4 treatments, arranged according to a 2 \times 2 factorial design, were the basal diet alone (RS), or RS plus fresh cassava foliage at 3% of LW (fresh basis) (RSC), RS plus single oil drench (cooking oil at 5ml kg⁻¹ LW) (RSO), or RSC with oil drench (RSCO). Rumen samples were taken at 7th, 14th, 28th, 56th and 84th day related to oil drench to determine pH, ammonia concentration and protozoa count. Daily feed intakes and fortnightly liveweight were recorded for 4 months. Oil drench reduced protozoa population. However, there was a rapid re-infestation of the small protozoa (mainly Entodinia) to a level comparable to control group. Only a few large protozoa (mainly Polyplastron and Holotrichs) were observed, being present in significantly ($P < 0.01$) smaller numbers than in non-oil animals. The overall protozoa biomass throughout the 84 days trial was estimated to be at least 4 times lower than non-oil groups. Rumen ammonia concentrations were significantly ($P < 0.01$) lower in oil drenched animals. Feed intake increased significantly ($P < 0.01$) in both oil and non-oil animals as cassava foliage was supplemented but was not significant affected by oil drench. However, growth rates increased significantly by the oil drench ($P < 0.05$) and cassava supplement ($P < 0.01$), the mean values were 53, 124, 210 and 302 g/day (SEM \pm 45) for RS, RSO, RSC and RSCO, respectively.

XI.16 Effect of good sanitation and udder preparation with chlorine solution on subclinical mastitis in Thailand

Simasatitkul, N., Srijumroon, S.

Department of Animal Nutrition, Chiang Mai University, 50200 Chiang Mai, Thailand. (agismkch@chiangmai.ac.th)

Smallholder dairy farmers in Chiang Mai Province, Thailand normally do not follow good sanitation in dairy production leading to a prevalence of subclinical mastitis in the dairy herds. This study was carried out to demonstrate to the farmers, advantages of following good sanitation procedures. Forty dairy farms in Chiangmai Province, Thailand, of which the owners had been trained on dairy farming and milking management were divided into 2 groups: good sanitation and poor sanitation. Good sanitation group practised regular use of chlorine before milking and poor sanitation had irregular use of chlorine before milking (42.5 % and 57.5 %, respectively). Farmers in the first group used chlorine solution to clean the cow's udders before milking significantly ($P<0.05$) more frequently than those in the second group (52.9 % and 21.7 %, respectively). Milk samples ($n=2908$) from 122 dairy cows were collected once a month for 11 months and tested for sub-clinical mastitis using the California Mastitis Test (CMT). Milk samples from the first group showed significantly ($P<0.05$) lower positive results to CMT than those from the second group (8.25 % and 18.15 %, respectively). However, the percentages of milk samples with positive results were not different between cows on regular chlorine use and those on irregular chlorine use before milking. Good sanitation and regular use of chlorine solution for udder cleaning before milking resulted in the least percentage incidence of milk samples with positive CMT results (7.85 %). The severity of sub-clinical mastitis was also significantly ($P<0.05$) decreased. Farmers in this region are therefore always recommended to follow good sanitation procedures and use chlorine regularly for udder cleaning to minimise incidence of mastitis in their herds.

XI.17 Nutritive values and utilisation of passion fruit peel silage for dairy cows in Thailand

Sitthiwong J.¹, Mikled, C.¹, Vearasilp, T.¹, Kunaporn, V.¹, ter Meulen, U.²

1 Department of Animal Nutrition, Chiang Mai University, 50200 Chiang Mai, Thailand. (agismkch@chiangmai.ac.th). 2 Institute of Animal Physiology and Animal Nutrition, Department of Tropical Animal Nutrition, Georg-August-University, Kellnerweg 6, 37077 Göttingen, Germany.

The studies were undertaken to evaluate the potential utilisation and nutritive values of silage made from passion fruit peel by using nylon bag and gas production techniques. The treatments were as follows: 1) Passion fruit peel silage (T1); 2) Passion fruit peel ensiled with 3% urea + 10% rice straw (T2), 3) Passion fruit peel ensiled with 4% rice bran (T3), 4) Passion fruit peel ensiled with 4% corn (T4) 5) Passion fruit peel ensiled with 1% formic acid + 10% rice straw (T5). It was found that the CP contents varied from 11.76% (T3) to 6.05% (T5). The potential degradability (A+B) and effective degradation (ED) from T4, T3 and T1 were higher than T2 and T5 respectively. The prediction values of ME and NE by gas production technique from T3 (10.09 and 7.20 MJ/kg) were higher than from T1, T4, T2 and T5 (9.88 and 6.09, 0.22 and 5.70, 8.07 and 5.19, 8.35 and 3.77 MJ/kg, respectively)

XI.18 Effect of feed supplementation with Quillaja saponins on growth and metabolism of male tilapia, *Oreochromis niloticus*, during grow-out.

Teteh, S.E., Francis, G., Focken, U., Becker, K.

University of Hohenheim (480b), Institute for Animal production in the Tropics and subtropics, Department of Animal Nutrition and Aquaculture, D- 70593, Stuttgart, Germany.

Tilapia are among the most important cultured fish (world production of about 1 million mt., using mainly all-male populations, 98 % of which is produced in the developing countries). Feed costs contribute to about 50 % of the expenses of fish culture. We previously found sex-specific effects of dietary Quillaja saponins (QS) in tilapia. Here the effects of dietary QS on growth and metabolism of male tilapia are reported. 12 tilapia were placed individually in chambers of a respirometer system and were randomly assigned either a control diet (C group, 5 fish) or a diet containing 300 mg/kg QS (S300 group, 7 fish) respectively. The tilapia grew from the initial average body weight of 72 g to a final average weight of 279 g (C) and 294 g (S300). The Metabolic Growth Rate (MGR, liveweight gain (g) average kg^{0.8}/ day; 10.6 ± 2.6 g for C and 11.1 ± 1.2 g for S300) and Food Conversion Ratio (FCR, g feed/ g gain; 0.84 ± 0.24 g for C and 0.87g ± 0.09 g for S300) tended to be better in the S300 group. There was no evidence of metabolic stress on the fish and the organ weights were similar in both groups. The growth parameters described above were considerably higher in the S300 group after the initial 9 weeks of the experiment (body weight of 245 ± 24 g against 227 ± 38 g in C, MGR of 12.7 ± 0.9 against 11.9 ± 1.6 in C and FCR of 1.07 ± 0.21 against 1.37 ± 0.7 in C). The differences between the groups narrowed during the next 3 weeks. It could be seen that dietary QS was able to reduce the amount of feed needed to produce one gram gain by about 28 % until 9 weeks of the experiment showing that supplementation of the diet with this substance has potential for considerably reducing feed costs. The optimal level and timing of supplementation need to be estimated through further feeding experiments.

XI.19 The effect of chlorocholine chloride in diets of laying hens on selected egg physical parameters

Songsang, A.^{1,2}, Thinggaard, G.², Vearasilp, T.¹, ter Meulen, U.²

1 Department of Animal Nutrition, Chiang Mai University, 50200 Chiang Mai, Thailand. (agismkch@chiangmai.ac.th). 2 Institute of Animal Physiology and Animal Nutrition, Georg-August-University, Kellnerweg 6, 37077 Göttingen, Germany.

The effect of chlorocholine chloride (CCC; a plant growth regulator) inclusion in diets of laying hens was evaluated. One hundred and fourteen chicks (initially 3 weeks old) were randomly divided into 4 groups. The chicks were fed a basal diet containing 170 g/kg DM crude protein (CP) for the first 3-8 weeks, 140 g/kg DM CP from 9-20 weeks and 165 g/kg DM CP up to one year. The dietary energy was 11, 10.6, and 11 MJ ME/kg DM in the three growth phases, respectively. To the basal diet, CCC was included at 0 ppm (0PPMC), 5 ppm from 15 weeks (5PPMA), 5 ppm from the beginning (5PPMB) and 50 ppm from the beginning (50PPMB) and offered to the respective four groups. Eggs were collected for the assessment of egg weight, yolk and white, shell weight, thickness and strength. There were no significant ($P>0.05$) differences in egg weight across treatments. Average egg weight was 59.0 ± 0.678 g. In contrast, there was a significant ($P<0.05$) 6.14 % depression in egg yolk only in 50PPMB compared to 14.963 g in 0PPMC. There was also a trend of a depression in egg yolk weight with inclusion of CCC in both 5PPMA and 5PPMB groups. There were no significant differences ($P>0.05$) in egg white and shell weight across the treatment groups. They were 38.7 ± 0.248 and 5.58 ± 0.0716 g, respectively. Proportion of egg yolk, white and shell were also not significantly different ($P>0.05$). They averaged 24.8 ± 0.408 , 65.5 ± 0.325 , 9.62 ± 0.0825 %, respectively. However, there was a significant ($P<0.05$) depression in % egg yolk and increased % white and shell in 50PPMB compared only to the control treatment on the samples collected in the early stages of egg laying. Shell strength and thickness were not significant ($P>0.05$) across the dietary treatments. They were 3.382 ± 0.0589 kg and 0.385 ± 0.00265 mm, respectively. This study shows that CCC inclusion in diets of laying hens particularly at 50PPMB has a depressive effect on egg yolk content and a tendency to lowering egg weight, but no effect on shell quality.

XI.20 Rainbow trout culture in Thailand

Unsrison, G.¹, Pornsopin, P.¹, Hörstgen-Schwark, G.², ter Meulen, U.³, Vearasilp, T.⁴

1 Chiang Mai Inland Fisheries Center, Department of Fisheries, Ministry of Agriculture and Cooperative, Thailand. 2 Institute of Breeding and Animal Husbandry, Department of Aquaculture, Georg-August-University, Albrecht-Thaer-Weg 3, 37075 Göttingen. 3 Institute of Animal Physiology and Animal Nutrition, Department of Tropical Animal Nutrition, Georg-August-University, Kellnerweg 6, 37077 Göttingen, Germany. 4 Department of Animal Nutrition, Chiang Mai University, 50200 Chiang Mai, Thailand.

This study was carried out to determine the biological feasibility of rainbow trout culture at high altitude in Thailand. Four groups of trout eggs obtained from America, Germany, Nepal and Finland were donated to the Royal Project from February 1998 to June 1999. All eggs were transported to the trout farm at 6°C in controlled temperature boxes. Trout eggs were incubated in incubation troughs at 10-12°C water temperature with 6 L/min water flow-rate. The incubation period of eyed eggs was 8-10 days and hatching percentages of 86-100 were obtained. After hatching, yolk-sac fry were moved to nursing troughs and fry were fed on 52 % protein trout starter feed 12 times daily. After one month of age, fingerlings were stocked in 30 x 2 x 1.2 m concrete raceways. These were supplied with water at the rate of 250-500 L/min. Stocking density of fingerlings was 3 000-5 000 fish per pond. The fingerlings were fed daily with 40 % protein floating pellets at 1-3 % of body weight per day. Average water temperature during the culture period was 18°C. Despite varying on-growing regimes at 6-8 months of age, on average the fish had attained the marketable weight size (250-300 g). The survival rate was higher than 80 % and average food conversion rate of 1.5. This study shows that rainbow trout can be successfully reared in the Highland region of Thailand and there is therefore scope for farmers in this region to go into large scale rainbow trout production.

XI.21 Small scale swine raising in Cambodia

Vathana, S.¹, Kang, K.¹, Chhum Phith, L.¹, ter Meulen, U.²

1 Faculty of Animal Production and Health, Royal University of Agriculture, Phnom Penh, Cambodia. (uv855001@mobitel.com.kh).

2 Institute of Animal Physiology and Animal Nutrition, Department of Tropical Animal Nutrition, Georg-August-University, Kellnerweg 6, 37077 Göttingen, Germany.

After a long period of political changes rice is still the main product of the peasant Cambodian farmers, although swine production on family scale continue as an important side line. Industrial pig production barely appears in some cities. Swine population in Cambodia is divided into two kinds: local and exotic breeds. The advantages of local breeds are climate and disease resistance, proliferation and unselectively eating. Serious disadvantages are slow growth and bad ham quality. Exotic breeds have the opposite advantages and disadvantages. Swine raising systems depend upon the favourites of farmers, possibilities, working time, feed resources and the patience of people. Raising systems are: uncontrolled i.e., moving free in the village, yard, tethering and housing systems. Every system have their own pros and cons. The swine feeds vary according to availability, cost, region, raising plan and raising system. The feed consists mainly of local grown plants of which the feed values are either not yet determined or not known in the villages. Concentrates are barely used. The main feeds used are rice and its by-products, fermented rice, corn, soybean and its by products, molasses, fish meal, water convolvulus (*Ipomoea aquatica*), water lettuce (*Pistia stratiotes*), banana (*Musa balbisiana*), and other forages, waste fruits and vegetables and the kitchen waste. Swine diseases and parasites are responsible for serious losses every year. Due to shortage in vaccination, disease prevention and control the swine are susceptible. Disease prevalence varies from season to season. The swine raising techniques among the Cambodian farmers are fairly simple due to the low level of knowledge. Surveys of the present situation are made to identify the major shortages. Based on these, practicable suggestions can be made for improved production practices and extension staff educated accordingly.

XI.22 Pregnancy test on urban and periurban dairy farms in the Maseru District/Lesotho

Gilles, P., Tawfik, E.S.

*Department of International Animal Husbandry, University of Kassel,
Steinstrasse 19, D-37213 Witzenhausen (ruraldev@pixie.co.za)*

In cooperation with the Department of Livestock Services Maseru on 102 farms pregnancy testing was done. The tested population on these farms was 306 dairy cows. The testing was done by hand at the earliest 5 weeks after insemination. The result shows that the pregnancy rate was 55% with no significant differences between the urban and periurban survey region. The survey has shown that not reproductive diseases are the reason for the bad pregnancy rate. Only 6% of the tested population had cystic ovaries and only 0,6% a uterus infection. A big influence seems to have been bad management especially in the field of heat control and feeding. To see the influence of the feeding management and of the body condition concerning pregnancy rate, the tested cow population was divided into different body condition classes before testing for pregnancy. The body condition scoring was done according to the Metzner-Heuwieser-Klee method. Classification for body condition scoring was done according to a 5-point range. Range: 1 skin and bone, 2 slim, 3 medium, 4 fat, 5 very fat. The classification was done through visual classification. A continued weighing of the test population and classification in weight classes were not possible on the researched farms. The best results were found in body condition classes 3 with 63,09% and class 4 with 75%. Animals with a bad body condition (class 1) and fat animals (class 5) showed a very low pregnancy rate.

XI.23 Urban and Peri-urban Dairy Cattle Farming in the Maseru District/Lesotho

Gilles P., Tawfik, E.S

*Dept. of International Animal Husbandry, University of Kassel,
Steinstrasse 19, D-37213 Witzenhausen (ruraldev@pixie.co.za)*

The dairy production in Lesotho and especially in the capital Maseru has over the last few years gained more and more importance. The infrastructure for dairy production is appropriate and a big demand of milk and milk products can be seen. The research will show whether improved dairy cows are able to reach their production potential under given circumstances and whether the farms are able to produce milk in an economical way. Dairy cattle farms were chosen in a multi-phase process for the quantitative data survey (1997 - 1999). In the first phase 173 farms (peri-urban 99/ urban 74) were chosen at random and a standardized questionnaire was carried out on the farms. The survey area included Maseru (urban) and the surrounding villages up to 30km from the city (peri-urban). In phase two 30 farms from each region were chosen for further detailed survey. The mean size of a herd in the surveyed area is 3,23 dairy cows whereby in the urban area the herd size is 3,87 animals per farm much higher than the average in peri-urban farms with 2,63 dairy cows. Animals of the breeds Friesland (81,4%), Brown Swiss (7,2%) and Jersey (5,3%) are mainly kept. The genetic potential seems adequate for a market - oriented commercial dairy cattle farming and is utilized quite well with relatively extensive conditions by a daily production of an average of 13 liters. The milk is sold to 60,56% (peri-urban 37,9%, urban 62,1%) through the formal sector and to 33,87% (peri-urban 45,7%, urban 54,3%) of the daily production through the informal sector. The prices on the informal sector are 64% higher than via the formal sector. Dairy farming has an important function from the farming as well as from the socio-economic point of view. Dairy farming can be an important source of income and self-sufficiency of a family in the survey area. Summarized, it can be seen that dairy farming in the survey area is profitable and dairy cows get the most from their genetic potential under the mainly extensive keeping conditions.

XI.24 Studies on the estimation of protein deposition and maximum growth capacity for Tilapia hybrid (*O. niloticus* and Red Tilapia).

Mohamed, Kh., Liebert, F., Rimbach, M., Rosenow, H.

*Institut für Tierphysiologie und Tierernährung der Universität
Göttingen, Kellnerweg 6, D-37077 Göttingen (kmohame@gwdg.de)*

Ten semi purified diets were formulated with fish meal and wheat gluten (3:1, constant ratio) from 16% to 48% CP (diets 1-5 were isoenergetic) and from 16-48% CP (diets 6-10, were adapted in their energy levels). Threonine was the limiting amino acid (except diet 8). These diets were fed 3 times/day for 70 days in triplicate to hybrid tilapias (*O. niloticus*?) and red tilapia (*O. mossambicus* x *O. hornorum*, B?) with an initial body weight of $12,3 \pm 0,10$ g . 25 fish/tank in recirculated filtered rearing system maintained at 27-28 C° were analyzed. The results indicated that independent on CP-level and feed intake of the diets hybrid tilapia grew significantly faster on diets with 32%,40%,48% CP than on the other diets. The SGR-data followed the same pattern as weight gain. Furthermore, the most efficient FCR-data were observed for 40% and 48% CP indicating genotype and sex differences to total amino acid requirements. The daily N-deposition (mg/d) increased with increasing level of protein and net protein utilization (NPU%) decreased with increasing protein content. The calculation of maximum daily N-retention capacity, based on graded CP levels of diets 1-5 resp. 6-10, resulted in 410 mg/BWkg 0,67, independent on genotype of fish and level of energy.

XI.25 Application of Stochastic Frontier Analysis on technical efficiency of floating net cage aquaculture: A case study on small fish farmers in West Sumatra, Indonesia

Munzir, A., Heidhues, F.

*Institut für Agrar- und Sozialökonomie in den Tropen und Subtropen,
Universität Hohenheim, 70593 Stuttgart, (munzir@uni-
hohenheim.de)*

This study deals with the application of Stochastic Frontier Analysis (SFA) on technical efficiency of Floating Net Cage Aquaculture production of small fish farmers in West Sumatra, using data from farm household of 80 small FNCA fish farmers surveyed in 1997/1998. Two stochastic frontier with technical inefficiency models in translog and Cobb-Douglas functional forms are applied. The parameters of stochastic production frontier model and those for the technical inefficiency model are estimated simultaneously using the maximum-likelihood estimation program of FRONTIER Version 4.1. The significance of parameter coefficients of the models are examined by applying asymptotic t-ratio and generalized likelihood-ratio test. The results suggest that there are substantial inefficiencies in the FNCA production of small fish farmers in West Sumatra indicated by the models applied. By operating at the production frontier or at full technical efficiency levels, small FNCA fish farmers in West Sumatra could increase their productivity from about 25 to 40 kg m⁻² with an initial seed input of 5.6 kg m⁻² over a time horizon of 2.4 months on average. Efforts to reach the production frontier could include improvement of the following determining factors for the technical efficiency of FNCA production of the small fish farmers, i.e., stocking density, feeding intensity, rearing area, and cage depth.

Symposium XII

Participatory Research

XII.1 DTT 2001 – Symposium ,Participatory Research'

Over the last decades, participatory research (PR) approaches and methods have increasingly found acceptance and a wider application within the international scientific community. A reorientation towards farmer participatory research was also fostered by donors who demanded more visible impacts through development-oriented research, especially in smallholder farming. However, while some 'islands' of success have been documented, participatory research is far from being mainstream in international agricultural research. PR still faces considerable implementation problems, and frequently encounters institutional and structural limits.

The present Symposium on 'Participatory Research' aims at discussing and reflecting on '*Constraints encountered in Institutionalising Participatory Research*' (covering the spectrum from strengthening the capacities of farmers and rural communities to experiment and innovate, to institutionalising a PR perspective in NARS, universities, IARCs, funding mechanisms etc.).

Three presentations will be given to introduce the topic:

1. A summary of the results from a comparative case study and a workshop held in the Philippines on '*Experiences in institutionalising PTD*' (Laurence v. Veldhuizen)
2. A summary of the major results from a workshop held in Chiang Mai, Thailand on '*Opportunities and limitations of PTD in Southeast Asia*'. (Andreas Neef)
3. A reflection about the strategic use of participatory communication tools by livestock scientists (Brigitte Kaufmann)

We suggest to realize (a 1-hour) '**fishbowl' discussion afterwards**: The keynote speakers and three voluntary people from the plenary will be invited to initiate a discussion round. If somebody leaves this group, new people from the plenary can join the round and take the seat that became available.

During the discussion we would like to address the following questions:

1. What are characteristics or 'cornerstones' of successful and high quality participatory research?
2. What are the main constraints and obstacles for a wider implementation of participatory research?
3. What are the key issues for institutionalising participatory research?
4. What are concrete steps and mechanisms towards an institutionalisation of PR?

XII.2 Advancing Participatory Technology Development: an international comparison of experiences in institutionalising the approach

Waters-Bayer, A.¹, van Veldhuizen, L.¹, Killough, S.², Espineli, M.², Gonsalves, J.³

1 ETC Ecoculture, POB 64, NL-3830 AB Leusden, Netherlands. (ecoculture@etcnl.nl). 2 International Institute for Rural Reconstruction (IIRR), Y.C.James Yen Center, Silang, Cavite 4118, Philippines. 3 Toledo Apts, Maitim Segundo, Tagaytay City 4120, Philippines.

In the last decade, a growing number of organisations have approached agricultural research and extension in ways that involve farmers in all stages of the development process and that focus on strengthening the capacities of farmers and rural communities to experiment and innovate. It has been increasingly recognised that these approaches, often referred to by the umbrella term Participatory Technology Development (PTD), are necessary in order to improve agriculture and natural resource management, especially in the less well-endowed rural areas. Scientists, extensionists and other agricultural service providers have been learning to work together with farmers in supporting local initiatives to improve rural livelihoods. Some promising efforts have been made to institutionalise PTD within large organisations of agricultural research, extension and education/training – both governmental and non-governmental. This paper compares and analyses some of these recent experiences in institutionalising PTD. It is based on a study initiated by the International Institute for Rural Reconstruction (IIRR) in the Philippines and ETC Ecoculture in the Netherlands. The case studies come from a wide range of countries, including Brazil, Cameroon, China, Costa Rica, Egypt, Ethiopia, Honduras, India, Kyrgystan, South Africa, Sri Lanka, Tanzania, Vietnam and Zimbabwe. The foci of the comparative study are on how constraints encountered in institutionalising PTD were dealt with and how methodological innovations in the PTD approaches were made to permit wider application without comprising on the aim of strengthening local capacities to innovate and adapt to changing conditions in smallholder agriculture.

XII.3 Participatory Technology Development and Local Knowledge for Sustainable Land Use in Southeast Asia - A workshop synthesis

Neef, A.

SFB 564 "Sustainable land use and rural development in mountainous regions of Southeast Asia", University of Hohenheim (796), 70593 Stuttgart, Germany

In this paper the main highlights and controversial issues from an International Workshop on "Participatory Technology Development and Local Knowledge for Sustainable Land Use in Southeast Asia", held in Chiang Mai, Thailand from 6-7 June 2001, are discussed. Most of the presentations dealt with the current paradigm shift from purely supply-driven to more farmer-oriented approaches in the Southeast Asian region. While some participants suggested that agricultural research should be entirely farmer-led, other presentations called for a more balanced approach, as farmers are not the only stakeholders and potential beneficiaries of agricultural research. Some authors warned to romanticise local communities by neglecting internal power structures and local conflicts. These are often disregarded by practitioners of participatory approaches who strive for consensus to facilitate planning. It was also stated in the discussions that uncritical use of Participatory Rural Appraisal might become a tool for patronising local people instead of its original intention to empower them. The question whether the outcomes of Participatory Technology Development (PTD) should be considered private or public goods was controversially discussed. The most extreme view was that only the people directly involved in the cycle of technology generation should benefit from the results. However, most participants agreed that public support for PTD can only be requested if the outcomes in turn become public goods and are thus available for farmers working under similar agroecological and socioeconomic conditions elsewhere. On the other hand, the risk of misuse of local knowledge for commercial purposes has to be minimised. In a discussion group the question was raised whether researchers have to be accountable for all steps of the problem solving cycle, from problem identification to dissemination of technologies. It was argued that the roles of researchers have to change with increased involvement in participatory processes: they become facilitators of local people and mentors of new colleagues engaged in PTD. Finally, some authors emphasised that PTD should not be separated from more general questions of access to resources. The best technologies are of no use if the institutional and political framework prevents farmers from getting access to land, knowledge and other vital resources.

XII.4 Communication tools in smallholder livestock systems analysis

Kaufmann, B.¹, Lemke, U.¹, Dhamotharan, M.², Valle Zárate, A.¹

1 Institute for Animal Production in the Tropics and Subtropics, University of Hohenheim (480a), 70593 Stuttgart, (bkaufman@uni-hohenheim.de). 2 Institute for Social Sciences in Agriculture: Agricultural Communication and Extension, University of Hohenheim (430a), 70593 Stuttgart

It holds particularly for tropical smallholder agricultural systems that livestock husbandry should be looked at as a human activity rather than a biological process. Therefore a combination of methods of natural and social sciences are useful in analysing livestock systems. The strategic use of communication tools (cc-tools) within the context of participatory research, allows researchers to communicate with livestock owners about their views and perceptions as basis for their decision making process in a systematic way and across disciplinary barriers. The paper focuses on methodological reflections about the contribution of such cc-tools to a systems analysis approach referring to experiences with smallholders of the livestock production system in Northern Vietnam. Presenting the result and process of the two applied tools "resource mapping" and "seasonal calendar", it is shown how farmers' knowledge in livestock production according to their epistemology can be systematically communicated to scientists. The visualisation-aided tools enabled farmers to communicate their knowledge according to their own categories, criteria and cause-effect relations. The generated diagrams were used as source of information by analysing them from different perspectives: a) temporal (e.g. development over time), b) spatial (e.g. comparison of several areas), c) content (e.g. details on resources regarding quality and quantity) d) explanation (e.g. cause-effect relations regarding distribution and use of resources), e) extrapolation (e.g. comparison with other locations). This information complements data collected and measured by scientists in order to obtain a meaningful picture of the resources potentially available to the farmers and on possible ways of their efficient use.

XII.5 Participation and conflict management for a sustainable and multiple use of the state forest in Gualaco, Olancho, Honduras.

Kosmus, M.

*Georg-August-University of Göttingen. Institute of Rural Development, Waldweg 26,37073 Göttingen, Germany.
(Schroeder_kosmus@yahoo.com)*

During the last decades social forestry, participation, decentralisation and community involvement became central topics in the development debate on the management of natural resources. There is a general conviction that participation is a conditio to protect nature and to improve living conditions of the local people. But, there is still a need to face participation as a complex and non-automatic issue on the operational level of action. Complexity rises when the basic conditions to perform participation are not given. In addition, different interests of stakeholders can lead to conflicts, which often hamper the realisation of a multiple use of forests. The introduced M.Sc.- thesis is based on a case study which aims to identify and analyse constrains and potentials for participation in the management of the state forest in Gualaco, Honduras. The data was collected with qualitative and quantitative methods. Analytical instruments are based on literature review concerning conflict management, participation, collective action theory and common property regimes. The study identifies and analyses the most significant sociocultural characteristics of the stakeholders that are connected to the particular material context constituted by the forest. Irregularities within the forest administration, a mono-functional forest use, a lack of efficiency in cultivation methods of smallholders and conflicts between different social actors proofed to be main causes for the reduction of the forest cover. Local conflicts evolve from overlapping of formal and informal property rights, scarcity of resources and inequity in access to them, imbalance of power, corruption within the institutional framework and a particular socio-cultural pattern of interaction. In Gualaco, a view of the community as a heterogeneous entity with a dynamic hierarchy of social relations can help to develop feasible strategies for an improvement of the welfare of the community. Part of a modified strategy should be the creation of inclusive institutional spaces, the development of need-focused management plans and an increase in visibility of weaker actors. An effective participation requires the presence of basic conditions, if these are not encountered they must be created. Only if the prerequisites are fulfilled, participation can comply with its function to be a vehicle for sustainable development.

XII.6 The potential of platforms to promote agricultural innovation development and diffusion in Fiji

Bachmann, L.

*Humboldt University Berlin, Breiteweg 1, 35415 Pohlheim, Germany.
(l.Bachmann@gmx.de)*

The potentials of different actors to collaborate better with the aim of developing agricultural innovations were investigated at the Ministry of Agriculture in Fiji. An organisational review of Two workshops, five case studies and a questionnaire were used to investigate the situation. The analysis showed that a number of small structures or networks existed that could be perceived as platforms. The majority of platforms were donor-funded projects or commodity boards. Newer projects using participatory methods were more successful in developing innovations, and as yet, also partly successful in the extension of these innovations. In this respect these donor-funded platforms assisted to increase the overall output in terms of useful innovations by the Fijian agricultural knowledge system. Commodity boards were cases that managed to build up self funding sources through the export trade. However, for less commercial innovations, platform funding was not secured. The most successful platform was characterised by a balanced contribution and participation of all actors involved. Platform monitoring played a crucial role for success. The question, 'which actors qualified best for platform leadership', remained open. While experts played a leading role, capacities of local research and extension staff remained weak. Strengths of the platform model were identified as such: better co-ordination, improved linkages, better interplay of actors, better means to reach goals, reduced duplication of efforts, and better use of resources. Weaknesses were seen in the need to achieve consensus and co-ordination, the weakening of hierarchical authority due to increased flexibility, and the general lack of experienced-trained staff in the Ministry.

XII.7 Participatory Wheat Breeding Research in Ethiopia: The benefits of client participation and decentralised release decisions

Regassa, E. N., Manig, W.

Institute of Rural Development, University of Göttingen

Scholars have persistently argued that the conventional research approaches, which have served industrial and green revolution agriculture do not fit the resource-poor and complex farming of tropical agriculture. This can be witnessed by the poor performance of established National Agricultural Research System of tropical countries with respect to efficiency, equity, and sustainability criteria, the fact that led to the emergence of new style of agricultural research known as Farming Systems Research and its various extensions. The main concepts underlying the new research paradigm are clientele orientation, the concept of systems and participation. However, the practical implementation and institutionalisation of this new approach usually faces resistance under many situations. This paper assesses the possibilities and limits of researchers and farmers collaboration in wheat breeding research in Ethiopia based on empirical results. The results show that there is substantial divergence between the two groups in variety selection process. The farmers use several criteria in their variety adoption decisions, while professional researchers consider only few mainly yield and they do not look for best one variety like professional breeders do; they select different varieties that fit to their various circumstances. Failure to take into account farmers selection criteria would lead to variety release and non release errors, which in turn embodies substantial opportunity cost to the farmer and to the nation. Optimal collaboration in crop breeding between farmers and professional breeders could potentially be threatened by the differences in socio-cultural variables, attitudes, and epistemology.

Symposium XIII

Conflicts, Migration and Rural Development

XIII.1 Implications of Household Assets and Improved Agricultural Practices on Child Work in Rural Ethiopia

Admassie, A.

Center for Development Research (ZEF), University of Bonn, Walter Flex str. 3, 53113 Bonn, Germany

Child labour has become a widespread phenomenon since the industrial revolution, despite legislations prohibiting the inclusion of under-aged children in the labour force. The problem is closely associated with poverty and backwardness where children are required to contribute significantly to household income by working either in the labour market or by directly contributing to household labour demand. Today the problem of child labour is a developing country phenomenon where millions of child workers are found toiling in wage employment and in domestic and farm work even at the cost of their human capital development. Most empirical works on the topic have disproportionately focused on the visible forms of child labour mostly in the manufacturing sector in Southeast Asia. In the case of Sub Saharan Africa child labour is mostly a rural phenomenon. About 80 million children are believed to be participating in domestic and farm work and the number is expected to increase to over 100 million over the next ten years. Ethiopia is characterised by high degree of poverty and recurrent drought and famine, high population growth, and low technological development all of which increase the propensity of child work and is one of those countries in Africa where the incidence of child labour is very high. The purpose of this paper is to provide empirical evidences on the link between poverty and child labour within the context of a subsistence rural economy by explicitly integrating household asset profiles and improved agricultural practices and using a multinomial logit model. Data from a recent rural household survey in Ethiopia have been used. The results show that household physical assets could discourage school participation and increase the propensity of child work. Similarly the adoption of improved technology also has important implications on child labour. The results points to important policy interventions to encourage greater educational attainment for children and reduce harmful child work. They enable policy makers to identify the type of productive assets to be provided to household as a poverty reduction measure and the type of labour saving technologies that could displace child labour from farming and encourage schooling.

XIII.2 Rural Poverty Alleviation through Non-farm Income in Transition Economies

Knüpfer, J., Buchenrieder, G.

University of Hohenheim, Department of Development Theory & Agricultural Policy in the Tropics and Subtropics (490a), 70593 Stuttgart, Germany, (knuepfer@uni-hohenheim.de).

Poverty and unequal income distribution increased dramatically within the last decade in the transition economies of Europe and Central Asia. While the percentage of the population living in absolute poverty (based on available 2.15 US\$ per day) is close to nil in Slovenia, the Czech Republic and Croatia, between 40 and 70% of the population in Tajikistan, Kyrgyz Republic and Armenia fall below the poverty line. In principle, all transition countries experienced an economic breakdown at the beginning of the transformation process. However, this breakdown was more severe and more prolonged in some regions. Various reasons may be given to explain the dramatically increasing poverty. On the one hand, the transformation process caused a collapse of the social and economic infrastructure. The declining domestic production, on the other hand, put pressure on the public budget due to reduced tax revenues and private income. The sharp drop in demand for labor entailed large declines in employment and wages. Particularly in rural regions, hidden unemployment in the agricultural sector can be observed. The probability that a rural household falls below the poverty line is thus 50% higher than for an urban household in a transition country. This contribution will focus on the extent of rural poverty in the Balkans, specifically Bulgaria and Romania. Based on the structure of the private agricultural sector in these two countries and based on the programs and instruments favored by the European Union for rural development, the contribution will outline ways how rural poverty can be reduced by strengthening the non-farm sector. The unsatisfying development in the agricultural sector of these two countries and other transition countries will require strategies to secure rural livelihoods. Two processes are apparent: a demand-pull process, where rural people respond to new opportunities; and a distress-push process, where the poorest are driven to seek subsistence farming and/or non-farm employment as a survival strategy. The reduction of rural poverty is important in view of the EU's accession plans in Central and Eastern Europe. The importance of the non-farm sector needs thus attention as the EU will adopt a more agricultural and rural face than ever before.

XIII.3 Wage labour instead of agriculture? The role of non-agricultural income for small-scale farms. Examples from Western Guatemala

Wyrwinski, R.

Universität Hamburg, Institut für Geographie, Bundesstr. 55, 20146 Hamburg, Germany. (fg6a083@geowiss.uni-hamburg.de)

During the last years non-agricultural employment has gained importance for rural regions of many developing countries. Nowadays, in Guatemala's Western highlands agriculture is no longer the main source of income for many smallholders. The increase in population density, the decline in agricultural area per capita and the degradation of soil resources by inappropriate land use systems have resulted in wage labour and self-employment as well as financial remittances becoming major sources of income for small-scale farms. Apart from the access to land it is the type of farming system and, in particular, the ethnic identity of the smallholder which determine the composition of the non-agricultural income (NAI). In semi-permanent cultivation systems NAI mainly originates from local day-labour whereas systems with perennial crops obtain most of their NAI from migratory work. In contrast to "ladino" farmers who are almost totally dependant on low-paid work in local trade and services, the majority of "Indian" peasants earn their NAI from seasonal migration to both the Pacific lowlands, the United States or Mexico and from manifold self-employed work in arts and handicraft. Despite its re-orientation towards small-scale agriculture, the agrarian policy of the Guatemalan government actually does not take these facts into account. Rural development planning still aims at the expansion of non-traditional export crops to commercialise smallholder agriculture, without considering the important role of NAI for the survival of peasant households. A fundamental change in the national agrarian policy is required.

XIII.4 Sustainable livelihoods and farmers decision making behaviour in the Westbank, Palestine

Dengler, B.

Universität Hohenheim, Institut 430 A, 70593 Stuttgart.

The actual situation in Palestine underlines the importance of questions of power and control over natural resources and institutional processes, to the analysis of vulnerability and sustainability in the agricultural sector and therefore calls for a focus on the embeddedness of agriculture in the social and political environment. This study is based on empirical material and data, collected in five Palestinian villages. Two theoretical concepts are combined and serve as a framework to the identification of the stakeholders priorities regarding sustainability and to the analysis of the relation between household resources, decision making, household strategies and expected outcomes in view of a specific social and political setting. With Bourdieu's understanding of 'social structure', (economic, social, cultural and symbolic) 'capital', 'habitus', and 'position', the rural Palestinian society is approached in order to depict groups of actors, their priorities and perceived options and to conclude on the relation between distribution of resources, power and potential range of action. The 'sustainable livelihood approach' further operationalises the forms of 'capital' by attributing the meaning of assets. The practical use rural families make of these assets to satisfy farm or household needs is analysed in relation to the context of vulnerability and farmers' considerations of economic, social and ecological sustainability. The study shows that the high level of social, political and economic insecurity favours flexible and reactive decision making and short term planning. Household resources are diversified and investments are more likely to be made on several small scale 'projects', than on large ones. The lack of reliable institutions leads to an increasing importance of informal networks, based on personal relations. These networks tend, by way of the interests involved to be exclusive to the benefit of only few people and further expand existing social disparities. Palestinian farmers place high value on the accumulation of social capital in order to gain power and social security. The younger generation however, tends to seek economic independence, which under the current circumstances is only possible through outside agricultural employment and /or the accumulation of cultural capital.

XIII.5 Is Agricultural Research on the Relevant Trade? A Critical Assessment with Evidences from West and East Africa

Abele, S.¹, Kamara, A.², von Oppen, M.³

1 Institute of Agricultural Development in Central and Eastern Europe (IAMO), Halle (Saale) Germany. 2 International Water Management Institute (IWMI), Pretoria, South Africa. 3 Dep. of Agricultural Economics and Social Sciences in the Tropics and Subtropics, University of Hohenheim, Germany

Despite increasing globalisation, some regions such as Africa still remain in poverty. Nevertheless, research for developing countries is primarily focused on improving agricultural production especially for staple food crops. But for many of these crops, African countries might be disadvantaged in comparison to agro-industrialised regions. Under these circumstances, measures will not result in efficient allocation of resources. This raises the important question of how then should agricultural research move forward? Though responses to this question may be quite diverse, long-term research evidences from Kenya and Niger suggest interesting answers. In East Africa market oriented systems are found while the Djerma millet system of south-western Niger is rather subsistence-oriented. In contrast to Niger, Kenyan cropping systems are of higher potential, as they focus e.g. on perennials like coffee, where they have comparative advantages. Here, the success seems to be rather dependent on institutional conditions. For example farm size has an important impact on agricultural productivity. Thus, the relevant question also in Kenya as well as in Niger is, how to assist small farmers in gaining ground on markets. These facts determine the future directions of agricultural research. For those most seriously affected by climatic and institutional shortfalls, policies should, in short term, aim on stabilising staple food production to maintain food security, but in the longer run seek for other opportunities than intensifying staple crops. Above all, income generation to purchase food instead of inefficient subsistence farming is the key word. For this, new products and new markets, in and outside agriculture, have to be sought. Agricultural research should also focus on niche-crops that are marketed, e.g. vegetables, or animal products. For the further development of farming systems that are promising in terms of an already existing market orientation, research and policies should aim at institutional strengthening and social organisation so as to enhance the access of small farmers to national and international markets.

XIII.6 No Tree - No Bee, No Honey - No Money. Approaches for the Improvement of Living conditions in Bee-Keeping Societies in the Forests of South Western Ethiopia

Hartmann, I.

Humboldt-Universität Berlin, Philippstr. 13, Haus 12, 10 115 Berlin

One of the reasons of increasing deforestation in the highlands of South Western Ethiopia has been the disrespect of traditional use rights for trees of beekeepers. The establishment of private and state plantations on the costs of community forests and communal grazing land lead to a severe depression of living conditions and family incomes in beekeeping societies, so that products taken out of the forests before, now have to be substituted in different ways. PRAs conducted in these areas about the perceptions of farmers concerning the changes of climate, soil fertility and biodiversity due to deforestation and their coping strategies showed that the current farming systems are no more adapted to the changing environmental conditions, losses of biodiversity of forests worsened the nutritional status, especially the availability of proteins and vitamins dramatically, losses of the honey-bee flora due to establishment of plantations accordingly increased the work load of farmers and reduced incomes from livestock and bee-keeping of about 50%. Especially the economic situation of women, whose cash income is mainly dependend on honey wine production, is affected by the reduction of honey production. Forest dwelling people of the lower castes, as the most vulnerable group, are the ones who suffer highest from the loss of access to natural resources. In need of following the forest, deforestation forces them to keep up a semi-nomadic lifestyle without any access to education and social services. Possibilities to cope with this situation are the establishment of a new honey-bee flora and modernization of the traditional bee-keeping system and intensification of livestock and cropping systems as well. The modernization of the bee keeping system is especially important: although traditional bee keeping is very efficient due to low need of investment, the productivity is low and the traditional technology also leads to a destruction of the bee population in long terms. The improvement of the honey bee flora is of double advantage, as it helps to conserve soils and forests on the one hand, and increases income on the other. That's why people say: No bee - no tree, no honey - no money.

XIII.7 Production systems and Livelihood strategies in southern Bolivia - A comparative study in the Natural Reserve Tariquía and its influence zone Valle Central

Seeberg-Elverfeldt, Chr.

Institute of Rural Development, University of Göttingen, Germany

In the National Reserve Tariquía and its influence zone the Valle Central, traditional socio-economic activities of the rural population are centred around agriculture and transhumant cattleholding. Due to forage shortages, every year farmers from the Valle Central take their cattle to the Reserve which graze for six months on forest pastures. In Tariquía households are subsistence agriculturalists, transport of products to markets is limited due to lack of roads. In the Valle households are market-oriented, but mainly small-scale producers. The discussion regarding livelihood systems raises the point that households, especially poor risk-prone ones, adhere to a portfolio of activities to assure their survival. Hence the objective of the study was to assess the production systems and diversification of livelihood strategies and its influence on each other. Data was collected of a randomly selected sample of households in two communities (within and outside the Reserve) using quantitative and qualitative methods. A gross margin analysis was conducted. Applying statistical tests, a comparison was drawn with regard to differences of production performance and livelihood diversification. Economic calculations reveal productivity and profitability rates of households outside the Reserve to be significantly higher than inside. Additional performance indicators demonstrate similar results. Various livelihood indicators, specific to the area, were selected, regarding the diversification within the production system, of livelihood strategies (activities others than agricultural ones) and migration. Higher diversification of non-agricultural activities within the Reserve is revealed, whereas production systems are more diversified outside. However, in total there is no significant difference to be observed in terms of diversification. Performance within their production systems is not related to the pursuit of a variety of activities. The Reserve Management can be advised to offer the population within the Reserve an amelioration of their agricultural production; on economical grounds an expansion of peanut and pig enterprises is advisable. Further crops, which are economically attractive and easily transportable should be introduced. To allow an income improvement other activities, such as further processing of timber and enhanced usage of non-timber products should be promoted. Nevertheless, for new options to be offered the sustainability needs to be appraised first.

XIII.8 Scavenging: is it a new path for farming families in Amazonia?

Vieira, A.L., Freitas, A.C.R.

*Federal University of Pará, Nucleus of Higher Amazonian Studies,
Belém-Pará-Brazil, (arimarlv@terra.com.br)*

In the middle of the 70's the introduction of large industrial and agricultural projects in the Brazilian Amazonia, created a situation of violence and loss of land used by farming families. In this sense, seeking for a better quality of life the process of migration for the Metropolitan Region of Belem, mainly from the interior of the State of Para was intensified. Completely excluded by formal labour market, these families started to collect disposed material as scavengers. The material collected is found in sanitary landfills, streets or open dumping areas as well. This research is being supported by Project MEGAM at the Nucleus of Higher Amazonian Studies of the Federal University of Pará, and has the main purpose of grasping to the understand the social and environmental relations inherent to collection and recycling activities in the Amazon Region.

XIII.9 Livelihood, Gender and Sustainability: Farmer's Strategies in East-Africa

Blume, A.

*University of Oldenburg, Department of Geography, D-26111
Oldenburg, (blumeanja@hotmail.com).*

Within the context of an ongoing study, successful farmer's livelihood strategies related to natural resources management are being assessed, analysed and illustrated by means of a comparative analysis of 18 small-scale, partly female-headed farms in two project areas in Tanzania and one in Kenya through applying a multi-method approach with main focus on participant observation. Interactions between the diverse activities and their effects on the families' socio-economic situation and their social environment as well as on the ecological conditions are elucidated under special consideration of gender aspects. The central question is: "Which successful farmer's and (women's) group's livelihood strategies/activities exist, what are their interconnections, and what is their contribution to ecological, economic, socio-cultural and political sustainability in the face of the speed of the degradation and destruction of natural resources and biodiversity?" The data analysis reveals the stabilisation and improvement of ecological conditions through a variety of measures implemented: tree plantings, natural tree regeneration, organic farming, promotion of traditional medicinal and food plants, physical measures, techniques of sustainable water and energy management, etc.; within this context, indigenous knowledge, e.g. with regard to traditional medicine, is an important factor. Furthermore, successful female and male farmers have a clear positive effect on their socio-cultural and economic environment as knowledge carriers and multipliers, e.g. within groups. Consequently, they function as important mediators between projects and people, especially marginal groups like poor farmers and female-headed households. Strengthening the position of open-minded and engaged female and male farmers within projects through their integration into gender workshops, training on resource management, study tours, etc. will enhance the success of project strategies. Moreover, this will contribute to a better quality of life of the target group as well as to the improvement and stabilisation of natural conditions, with far-reaching positive effects and implications even on the regional and global level.

XIII.10 Palm oil boom by local women: Changes of local knowledge systems and their results in Western Nigeria

Ay, P.

Socio-economist, consultant

The dynamics of local knowledge and its interaction with modern science is attracting increasing attention in the discussion on enhancing development in a local and global context. Field research in this domain has already contributed to explaining the relevance and potential of local knowledge. Research on the production of palm oil in Africa, however, still seems to be specifically suitable for analyses inasmuch as palm oil is widely produced by a range of different traditional methods. Various research methods and approaches have been applied in several studies which describe the processing steps for palm oil as multi-layered examples of complex local knowledge systems. This paper presents the results of a study in Western Nigeria. It analyses changes in palm oil production over a period of 25 years in a research area comprising 20 villages east of Ibadan in Nigeria. In the 1970s the majority of the women in the study area produced palm oil mainly for household consumption. Today, specialised women work in groups and use mechanised steps for several of the processing techniques. The oil is sold in urban, regional and rural markets at a largely standardised quality. There is also evidence that the output of palm oil has doubled in the study area in the last decade; the raw material is not obtained from new plantations, but rather through a more intensive harvest and better care for the existing trees, which is to a large degree encouraged by the women engaged in the palm oil production. The gradual establishment of a rent system for palm trees resulted in the palm oil producing women gaining control over the raw materials. These women can influence the harvest of palm fruits according to their processing organisation. Conflicts over land use rights are avoided, as the women are not formally owners of the trees. The study contributes to discussions on approaches and the application of appropriate methods of social research on local knowledge systems. In the early discussions of the relevance of local knowledge in developing countries, a contrast between local knowledge and modern science was often assumed. This paper, however, confirms approaches which base their analyses on the dynamics of local knowledge and the observation of the effects of continuous interaction between the local and modern "systems of knowledge". The large differences between the holders and users of local knowledge are comparable to the domain of modern science inasmuch as an elite which actively promotes innovations can also be identified for the local systems. This elite uses experiments and information exchange for the promotion of change. Specific to the palm oil production sector is the large number of women who are actively involved at the different levels.

Symposium XIV

Poverty and Livelihood Strategies

XIV.1 Migration and agricultural production: Between poverty and prosperity

Wiese, B.

University of Koeln, Geographisches Institut

Migration has severe impacts on agricultural production from downbreak to upward trends causing consequences from misery to prosperity. We will review causes for different types of migration and their effects. Implications for the prevention of disasters and for rural development will be proposed. Regions/ examples: Tropical and subtropical regions of the world, examples from Africa, Latin America and Asia. North-South relations.

XIV.2 Rural Poverty and Migration in Northeast Brazil - Implications for Policy Making

Höynck, S., Gaese, H.

*Institute for Tropical Technology, University of Applied Sciences
Cologne, Betzdorfer Str. 2, 50679 Cologne*

The major problem of Brazilian development is the inequality of income distribution. The phenomena of income disparity exists on various levels: On interregional level, where the Northeast forms the disadvantages counterpart of the booming South and Southeast; on inter-sectoral level and among the rich and poor within each of the sectors. The very bottom line of income distribution in Brazil are the rural poor of the semi-arid region in Northeast Brazil. Ceará is a typical example of contrasts in income generation and development. About 40 % of the work force is engaged in the agricultural sector, generating little more than 6 % of the GDP of Ceará. 70 % of the farms can be categorized as small scale farms of less than 10 ha. The majority of these farms is engaged in subsistence farming on an average farming area of about 2 ha. The subsistence sector is based on rain-fed agriculture in the very insecure environment of the semi-arid Sertão. Draught events do occur repeatedly depriving the population of their scarce food and water sources. The generally low income of the Sertão region in comparison to urban centers plus the threats of draught events result inevitably in rural-urban migration within Ceará, and also farther to the mega cities of the Southeast. To counteract this development, national and state policy provide a wide range of programs. These programs are 1) emergency programs, necessary to avoid famines and thirst in draught years; 2) Medium term programs of poverty alleviation, aiming at "keeping the people in the rural areas (out of the cities)"; 3) long term programs of supporting decentral regional development: urban and rural development, agricultural as well as industry and service sector growth. The most important actual and past programs and policy measures shall be presented and assessed in this paper. Future prospects will be presented, considering the agricultural sector developments, rural education and social welfare programs.

XIV.3 Manpower development in agricultural engineering in developing countries

Krepl, V.

Institute of Tropical and Subtropical Agriculture, Czech University of Agriculture Prague

Manpower development in Agricultural Engineering is one of the important objectives at present in the rural conditions of Developing Countries. The development of Agricultural Engineering has a big coverage to the social and economic context, that allows to educate people in the field of Agricultural Engineering, as an objective to increase the standard of living in the rural areas. The groupings of agricultural engineers represent a manner to collaborate with the development and extension of knowledge and its application in this field thereafter the development of agricultural engineering, as a profession is a very important factor to enlist the persons concerned by this field. The present status of agricultural engineering is an important element of development programs in The Developing Countries to improve situation in agriculture. The bellow mentioned test, where the four developing countries from the equatorial Africa was monitored, was applied as instrument for determining of actual state of Manpower Development in Agricultural Engineering in Developing Countries. The potential and crucial role of agricultural engineering, and therefore of agricultural engineers, in development has not always been recognized. A number of spectacular failures in the past involving poorly adapted schemes of agricultural engineering led planners to neglect and even resist investment in this sector. Yet, to neglect investment in this sector denies a society the possibility of raising its agricultural performance beyond subsistence levels. Manpower development is recognized as being of prime importance for the successful execution of agricultural development programs and continues to constitute a major component of FAO activities. Many developing countries are experiencing high population growths leading to ever increasing food requirements. Adequately trained personnel are essential for tackling this situation and the needs are particularly acute for engineers, technicians and craftsmen, trained in the skills required for the application of engineering to agriculture. The desirability of balanced and appropriate agricultural mechanization is now recognized as a vital ingredient in agricultural development plans. The engineering introduced must be effective and those charged with the tasks of its management and promotion must be adequately trained and educated. This publication aim to address the problems associated with planning the manpower resource requirements and the development or establishment of appropriate training facilities and programs. A practical project in the Manpower Development in Agricultural Engineering in the four countries of Africa was implemented. This project is present as a follow-up project of the FAO, AGSE Department projects which the one was realized on the end of eighties.

XIV.4 Own Machinery Versus Outsourcing in Southern Brazil - A Transaction Cost Approach

Wander, A.E., Zeller, M.

*University of Göttingen, Institute of Rural Development, Waldweg 26,
37073 Göttingen, Germany.*

The mechanization of agricultural production plays an important and over time increasing role in the course of agricultural and rural development. Mechanization offers a number of potential improvements to farming systems such as increased land and labor productivity, reduction of risks, and increase quality and food safety of animal and plant products. Yet, investments in own machinery, in particular for smallholders, may not be the least-cost option in comparison with outsourcing the required machinery services through different contractual relationships. For choosing the optimal contract for the procurement of machinery services, conventional machinery costs as well as transaction costs need to be evaluated. The main objective of the research presented here is to assess the role of transaction costs (TC) in the choice among alternative contractual arrangements for provision of machinery services. Our hypothesis is that TC are important cost elements and influence the choice of contractual arrangements for provision of machinery services together with machinery costs. The empirical data on conventional machinery and transaction costs were collected from farms in Southern Brazil that procure services for maize harvest through various informal and formal contractual forms. We show that transaction costs can influence the choice of contractual arrangements.

XIV.5 Population-Environment Dynamics in West Africa - Spontaneous agricultural colonization in central Benin

Doevenspeck, M.

Department of Geography, Meckenheimer Allee 166, 53115 Bonn, Germany. (M.Doevenspeck@giub.uni-bonn.de)

During the last sixty years the proportion of the population in the interior savannah region to that of the coastal regions in West Africa went from 50-50% to 32-68%. There is no other region of this size of the world that has undergone such a considerable transfer of population in one half century. The main target regions of this labour migration were the southern parts of the coastal states in the gulf of Guinea, attracting the migrants with job opportunities created by the export-bound agricultural development strategies. Beside these frequent international migration flows important internal migrations in most of the West African countries can be stated. Since its independence in 1960 the Republic of Benin experienced a substantial population movement, which can be subdivided into several phases and which proceeds from the densely populated north-western regions that are seriously threatened by desertification towards the south. High immigration rates and a population growth of over 3% led to Asian conditions in the south of Benin regarding land availability and land tenure. In recent years this development led to a reorientation of the migrants to the traditionally sparsely populated central region, especially to the triangle of Parakou - Djougou - Bassila, whose accessibility was improved by infrastructure investments. In this region the migrants find the last vacant agricultural acreages of Benin, whose population will have tripled in the year 2025 to approximately 17 million inhabitants. The current immigration process in the area of research and field-work is a spontaneous agricultural colonization, without any kind of intervention from national authorities. The objective of the author's research is a detailed geographical analysis of current immigration processes and their effects on the socio-political systems, settlement dynamics, the settlement pattern and regional resource utilisation. The quantitative and qualitative social data gathered via a mixture of methods (questionnaires, settlement mapping, GPS mapping of land use patterns, interviews, participatory observation) are linked with remote sensing data (Landsat TM scenes) and GIS-modelling for analyses addressing the 'why' and 'how' of population-environment issues.

XIV.6 Das Direkte Subventionszahlungsprogramm für eine umweltfreundliche Landwirtschaft in Südkorea

Chang, C.-L., Hoffmann, H.

Humboldt-Universität zu Berlin, Landwirtschaftlich-Gärtnerische Fakultät, Fakultätsschwerpunkt Ökologie der Agrarlandschaften, Invalidenstr. 42, D-10099 Berlin, Germany. (chul-lee.chang@student.hu-berlin.de)

Die aktuelle Agrarpolitik in Südkorea ist gegenwärtig darauf ausgerichtet, eine umweltfreundliche Landwirtschaft zu fördern. Dafür gibt es zwei Ursachen: Einerseits führt die intensive Landbewirtschaftung zu zahlreichen Umweltprobleme. Andererseits entstehen den Betrieben, die umweltfreundlich produzieren, Einkommensverluste durch eine geringere Produktivität. Besonders betroffen sind davon auch Betriebe des ökologischen Landbaus. Im Ergebnis der GATT-Verhandlung/Uruguay Round wurde die Inlandsintervention mittels der Preisunterstützung für die Agrarprodukte beschränkt (Seo et al. 1996). Deshalb gehört zu den Maßnahmen der Förderungspolitik das Programm "Direkte Subventionszahlungen für umweltfreundliche Landwirtschaft". Dieses Programm soll vom Jahr 1999 bis 2004 laufen (MAFF, 2001; Lee, 1998). Ziel ist, daß die Einkommensverluste der entsprechenden Betriebe durch direkte Zahlungen ausgeglichen werden, und die Situation kleinbäuerlicher Familienbetriebe verbessert wird. Am Direkten Subventionszahlungsprogramm können Betriebe unter folgenden Bedingungen teilnehmen: Lage: in Naturschutzgebieten, Betriebsgröße: größer als 1000m². Anbaustruktur: Landwirtschaftliche pflanzliche Produktion (ohne Industriekulturpflanzen), Einhaltung von Grenzwerten für Dünge- und PSM, Teilnahme des Betriebsleiters an einem Seminar. Allerdings sind neben den positiven Intentionen auch eine Reihe von Problemen bei der Umsetzung erkennbar. Im Poster-Beitrag werden Vorzüge und Nachteile des Programms am Beispiel von Bio-Betrieben in Südkorea dargestellt und Vorschläge für die Weiterentwicklung unterbreitet.

XIV.7 Land Use Changes in the Peri-Urban Area of Yogyakarta Region (Java/Indonesia)

Knie, Chr.

*Justus Liebig Universität Gießen, Institut für Geographie,
Senckenbergstrasse 1, 35390 Gießen
Germany. (christine.knie@geogr.uni-giessen.de.)*

Within the background of increasing urbanisation the land use of the densely populated agricultural regions of Asia and their potential possibilities of intensification have gained more and more in importance - especially in terms of nutrition backup and poverty reduction. The island of Java belongs to the most densely populated rural areas of the world. The province of Yogyakarta on Java includes an area of 3200 sq.km. with an average population density of more than 1000 people/sq.km. and the urban centre, Yogyakarta city itself of nearly 15000 people/sq.km. Concerning the driving forces of land use changes the exemplary research character of the peri-urban region of Yogyakarta is especially given by the varying agro-economic zonal structure of this relatively small research area. The fertile wetrice plain of the centre, the hilly limestone-karst area of Gunung Kidul in the east, the slopes of the Merapi volcano in the north, the mountainous area of Progo in the west as well as the coastal regions of the south. The investigation of the spatial structural change and its ecological and socio-economical consequences are - also with regard to the decentralisation of the administration - of special interest. The trend of land use development is different in every region though the whole area is influenced by the growing demand of the urban sprawl. With regard to the impact on the environment as well as socio-economic consequences of land use changes, various problems and conflicts are signed. The geographical faculties of Gadjah Mada University in Yogyakarta (Indonesia) and Justus-Liebig-University in Giessen (Germany) investigate the land use development of the traditionally agricultural embossed region Yogyakarta in order to point out sustainable possibilities of development and to provide adequate basic information for a decentral land use planning.

XIV.8 Influence of Road Infrastructure on Agricultural Transformation and Equity in Tanzania

Gabagambi, D., von Oppen, M.

University of Hohenheim, Institute for Agricultural Economics and social sciences in the Tropics and Sub-tropics (490B), D-70593 Schloß Osthof. (gabagamb@uni-hohenheim.de)

Transforming agriculture from subsistence farming units to commercial oriented productive enterprises with consequent eradication of poverty in rural area, for a long time has been one of the major government policies in Tanzania. However little has been achieved towards this goal. The influence of physical market access in terms of road network on the transformation process deserves attention. This paper addresses this issue by investigating the relationship between access to road and household social economic characteristics. Four centres along the Tanzania-Zambia highway (TANZAM) were selected. At each centre three villages at different relative distance from the highway were surveyed. In each village data on social economic variables were collected from 10 men and 10 women household heads selected at random. This formed a sample size of 240 respondents. Aggregate productivity, specialisation, intensification and market orientation of households were then deduced. Partial analysis showed that variables varied significantly with distance. As the distance from the household to the highway and to the feeder road decreased variables such as total productivity, producer prices, market orientation, level of education, income and input levels increased. On the other hand variables for example age, area under cultivation, level of input use, and family size increased as the distance increased. In a comprehensive analysis using a three stage least square method (3SLS) the tendencies observed in the partial analysis were confirmed. Specialisation and intensification increased significantly with road access. The results also show that improvement in road accessibility does not affect all actors equally in the system. Men headed households seemed to benefit more than women headed ones. This is because of men's economic power, which enables them to take advantage of improving situation in the production and marketing system. The policy implication for this is that strategies to improve the living standard of the poor such as women should include complementary programmes to raise incomes of weaker participants in the system.

XIV.9 Meat and fish consumption in Senegal with special focus on gender aspects

Riegel, M., Hoffmann, I.

*Dept. of Livestock Ecology, JLU Giessen
(Monika.Riegel@ernaehrung.uni-giessen.de)*

Meat and particularly fish play an essential role in the Senegalese diet as a source of animal protein. The objective of the study was to determine the level of consumption of both meat and fish. The study covers two consumer locations (urban and rural) and three regions with different agricultural production and food consumption patterns. While livestock production is dominant in the northern part of the country, most people in the South are farmers and fishermen. In Dakar people live from incomes of the formal and informal sector. Gender differences in consumption patterns are another focus of the study. For the demand side 359 households were interviewed, the interview partners being mainly women. At the household level the consumption for beef is higher than for poultry, mutton, game and pork. Rural Households consume more often small fish, dried fish or combine both than bigger fish. The level of meat and fish consumption differs between locations and regions. The urban population consumes the highest amount of meat (18.7 kg \pm 16.4) and fish (34.7 kg \pm 23.2) per caput and year, maybe due to better access to markets and a higher purchasing power. The per-caput consumption of the rural population is 11.6 kg (\pm 11.4) for meat and 21.9 kg (\pm 14.0) for fish. The urban population consumes a higher amount of fresh and bigger fish (34.7 kg \pm 23.2) than the rural (16.1 \pm 12.8 kg). In the rural areas, consumption of dried fish is higher (7.4 kg \pm 6.9) than in urban. All differences are significant at a level of $p < 0,05$. Consumption differences between Dakar and the other regions are significant. Apart from dried fish, the amount consumed per caput in Dakar is highest for all kinds of meat and fish. Expenditures for meat and fish are also highest in Dakar and lowest in the rural areas of the South. The amount of meat and fish consumed by the rural population is significantly lower in the South than in the North. One third of the interviewed households demands meat and fish dishes outside the household, too. Mostly they are demanded by men in the informal sector.

XIV.10 Conflict management between farmers and Fulani pastoralists: a case study in the southern Soudanian zone of Burkina Faso

Pickardt, T., Hoffmann, I.

*Dept. of Livestock Ecology, Justus-Liebig University Giessen
(tpickardt@hotmail.com)*

Traditional agricultural production in Burkina Faso mainly consisted in shifting cultivation. Due to the rapid population growth, fallow periods became shorter causing degradation of soils and vegetation (Savadogo, 2000). On the other hand, severe droughts in the 1970s and 1980s have led to a shift of livestock populations from the Sahelian Zone to the Sudan savannas. The higher grazing pressure increases the risk of vegetation degradation and often causes land-use conflicts with long established farmers. In the south-west of Burkina Faso, farmers usually try to exclude Fulani pastoralists from their village territories, fearing that the herds would cause damages to the crops (Slingerland, 2000). In a case study covering four villages in Poni and Nounbiel Provinces, Malter (2000) showed that conflicts occurred among farmers as well as between farmers and pastoralists. However, farmer to farmer conflicts about crop damage caused by pigs and small ruminants were usually solved peacefully, even if the animals were killed. Contrasting, conflicts with Fulani pastoralists tend to be more violent, because the Fulani are not integrated in the village community and refuse to accept responsibility for damage caused by their animals. Conflicts arise on compensation. A five months study was undertaken in the Poni Province in Southwest Burkina Faso. The village of Kour was investigated by transect walks, structured and informal interviews with farmers and pastoralists, and through interpretations of aerial photographs. The population in Kour village is composed of two ethnic groups: the Dagara are subsistence farmers or agro-pastoralists and live in the southern part of the settlement, whereas the partly settled pastoralists Fulani occupy the northern part of the village. Results show that Kour can be considered as an example of a fruitful coexistence. The main problems of the village are typical for the area: risk of water shortage during the dry season, a decrease of soil fertility and firewood scarcity. The typical conflicts between farmers and pastoralists (i. e. damages in the fields caused by the animals etc.) occur in Kour, but unlike in other villages, they are in most cases resolved peacefully by the involved persons. The population of Kour has discovered several advantages of good farmer-herder relationships, which are not yet common in other villages. After harvest, the Fulani herds are allowed to graze the stubble of the fields; the animals' dung helps to maintain soil fertility. Other relationships are linked to labour. The farmers work as daily labourers on the Fulanis' fields or help them constructing houses. Dagara women produce Karité (*Butyrospermum parkii*) butter and soubala with the fruits of Néré (*Parkia biglobosa*) trees for the Fulani women.

XIV.11 Women's Savings and Credit Co-operatives in Madagascar: Impact of 'Credit with Education' on Member's Quality of Life

Schott, J.

*Georg-August-University of Goettingen, Institute of Rural Development, Waldweg 26, D 37073 Goettingen, Germany
(johanna_schott@yahoo.com)*

Since the beginning of the nineties microfinance institutions were set up in Madagascar. The research project carried out on the east coast of the island was investigating a women's savings and credit co-operative, the Caisse Féminine with the program "Credit with Education". Subject of the study is the question if women's savings and credit co-operatives do have an impact on members' quality of life and living standard and if they help to alleviate poverty. As methods a qualitative pre-study, five case studies, a theory and a formal survey with 60 randomly selected women served as tool for the research. Main outcomes of the research are an obvious improvement of monetary income (73%) and enhanced food security (69%) for members of the Caisse Féminine. Most appreciated items of the program were the education lessons (65%) and friendship/solidarity of women (34%). After three years of implementation, the Caisse Féminine reaches its financial independence from its donor in the U.S.A. which can be seen as an indicator of success.

Contrary to improved food security, members of the Caisse Féminine still suffer from malnutrition which can be attributed to local cooking traditions and not only to their poverty. The biggest problem members have with the program "Credit with Education" is the weekly pay back of credit rates. The program "Credit with Education" is not adjusted to local conditions. Despite of the proved positive impact of the program the lack of infrastructure in the research area especially the lack of education, roads, and health institutions limits the success. In addition climatic risks like regularly cyclones and inundations threat the development on the east coast of Madagascar.

Symposium XV

Diffusion of Innovations

XV.1 Die Bedeutung des Themas Tropenwald für die politische Bildung

Wilmsen, Chr.

Leiter des Referats „Entwicklungspolitische Informations- und Bildungsarbeit“ des Bundesministeriums für wirtschaftliche Zusammenarbeit und Entwicklung, Bonn

Die wachsende Globalisierung konfrontiert die Öffentlichkeit mit einer Realität, die immer komplexer wird. Eine undurchschaubare Welt lädt jedoch nicht zum Lernen ein. Alle demokratischen Gesellschaften stehen heute vor der Gefahr, dass sich die Bürgerinnen und Bürger aus der Politik verabschieden und ins rein Private flüchten. Damit wird – ungewollt – die demokratische Willensbildung, die den politisch informierten und engagierten Bürger/-in zur Prämisse hat, unterhöhlt. Die ökonomische Globalisierung muss jedoch von demokratisch legitimierten politischen Systemen des „Global Governance“ gestaltet werden. Stärker denn je ist es Aufgabe der politischen Bildung, die Öffentlichkeit darin zu unterstützen, eine immer komplexere Welt zu verstehen und sich in den demokratischen Willensbildungsprozess einzubringen. Speziell für die Themen Entwicklungsländer und Eine Welt ist es sehr hilfreich, an den Vorbehalten und Wissensdefiziten anzuknüpfen, die laut repräsentativen Meinungsumfragen in großen Teilen der deutschen Öffentlichkeit existieren. Drei der Wichtigsten sollen angesprochen werden. Für ihren Abbau eignet sich das Einzelthema Tropenwald oft ganz vorzüglich. (1) Dem Lernen zum Thema Entwicklungsländer steht das Meinungsdefizit entgegen, hier ginge es um eine Fernproblematik. Diese Vorstellung lässt sich mit Tropenwaldbeispielen bekämpfen, die globale Interdependenzen deutlich machen. Zu denken ist an das Stichwort Regenwald als „Apotheke der Welt“ oder die Verdunstung über den großen Regenwaldflächen, die das Klima anderer Regionen, auch Europas, beeinflusst. (2) Das Lernen zum Thema Entwicklungsländer wird durch die Vorstellung behindert, in dieser Ländergruppe ginge es im Prinzip nur bergab. Ein solch pauschal negatives Bild ist jedoch weder zutreffend noch geeignet, Ohren und Augen für die Eine Welt oder den globalen Umweltschutz zu öffnen. Vielmehr lässt es die Menschen sich abwenden. Die Mechanismen der Presseberichterstattung („good news is no news“) spielen in diesem Zusammenhang eine tragische Rolle. Trotz allen Raubbaus und einer geschichtlich einmaligen Zerstörungsrate gibt es auch in Regenwaldgebieten bemerkenswerte Zeichen des Lernens und Umsteuerns. Vierjährige Beobachtungen in Brasilien sollen hier angesprochen werden. (3) Politisches Lernen und Engagement wird dadurch behindert, dass Millionen Menschen der Industrieländer unterstellen, sie seien politisch ohnmächtig – es lohne sich nicht, tätig zu werden. Zur Rettung der verbliebenen Tropenwälder können die Gesellschaften der Industrieländer sehr wohl beitragen. Auch für das Engagement der Einzelnen gibt es Optionen, die zu beachten sind. Stichworte sind u.a. „Fair Trade“, das FSC-Siegel oder die Nord-Süd-Kooperation der NRO.

XV.2 Research - Extension - Farmers Linkage System in Nigeria: The diffusion of innovations

Oladele, O.I.

*Department of Agricultural Extension and Rural Development,
University of Ibadan, Nigeria, (deledimeji@hotmail.com)*

The process of introduction and diffusion of innovations in Nigeria is depicted in the research -extension - Farmers Linkage system. Major innovations in the last six years have brought dynamic changes in the research -extension - Farmers Linkage system. The paper presents the methodology of the diffusion of innovation in Nigeria. The success, failures, options as well as challenges for the future. Conditions for effective linkage among research, extension and farmers to bring about improvement in the living conditions of farmers were also explored in the paper.

XV.3 Provision of Public Goods and Services and Quality of Life: A Survey of Four Districts in Ghana

Asante, F.A.

Institute of Statistical, Social and Economic Research, Univ. of Ghana, Ghana.

Ghana has for some years embarked on decentralisation of decision making, that is moving decision making from the national (center) to the district and community levels. Decentralisation has shown that local government officials are likely to be better informed about the members of their communities and better able to recognise those who are genuinely poor. Moreover, because poverty in one community may be characterised by different indicators than poverty in another community, a decentralised system may also increase efficiency of access to public goods and services by allowing local authorities to determine the local eligibility criteria. These local services and infrastructure not only contribute to achieving better quality of life but also enhance the productivity of labour, allow markets to work efficiently and create opportunities for employment and entrepreneurship which also help to reduce poverty and improve the standard of living of citizens. Quality of life is defined broadly as the degree to which a person enjoys the important possibilities of his or her life. The possibilities results from the opportunities and limitations each person has in his/her life. In this study health and education (public goods and services to be considered) outcomes such as level of school enrolment and child infant mortality rates would be used as indicators of quality of life. The main hypothesis to be tested in the study is that provision of public goods and services in a decentralised system would lead to improved outcomes or quality of life. Household and community data for four districts in Ghana are used in the analysis. This involves 420 households.

XV.4 The Impact of ICTs on Farmer Life in China

Wang, W.

ZEF, University of Bonn, Germany

The past decades have been observing the dramatic development and the rapid distribution of information and communication technologies (ICTs). In China, the telephone density rate rose from 0.38 sets per hundred persons in 1987 to 13 sets, an increase of almost 34 times by the end of 1999. The UNDP believes that those nations that succeed in harnessing the potential in ICTs can look forward to greatly expanded economic growth, dramatically improved human welfare. David F. Barr further pointed out that the greatest challenge for developing countries is to ensure that telecommunication services are extended effectively and efficiently throughout the rural and remote areas. Recognizing the significant impact of ICT application on economic development, especially in rural China, the author endeavours in this paper to address two main topics: (1) Conceptual studies, the characteristics of ICTs and their economic significance. (2) The impact of the application of ICTs on farm households, including both the determinants of access to ICTs and the impact of ICTs on farm households. In order to more accurately investigate the relationship between ICTs and farm households, a case study on telephone subscription in farm households was conducted by RCRE in the rural areas of three sample provinces. The results of analysis suggest that ICTs, such as telephone and Internet access, have a potentially significant impact on farm households in such various economic and social aspects as these: industrial patterns, market extension, improvement in education and health-care. The main determinants of telephone subscription for a farm household are net annual income, the educational level of head of household, the number of household members with professional titles, and sideline business types. There is a positive relationship between duration of telephone possession and the change in annual net income of a farm household. The result also shows there is no relationship between telephone subscription and shift of sideline business types of farm households in the short run.

XV.5 Bits, brains, and bread – international agricultural research in a wired world

Müller, R.A.E.

Department of Agricultural Economics, Christian-Albrechts-University, Kiel

Digital information technology (IT) provides new opportunities for agricultural research. Unfortunately, the diffusion of IT is accompanied by technological utopianism that may blur the proper assessment of IT's likely impacts. In order to arrive at a realistic assessment of the potential of IT for enhancing the productivity and effectiveness of agricultural research this essay is focussed on five themes:- key technological and economic characteristics of IT are briefly reviewed to provide a backdrop for the subsequent discussion of the impact of IT on international agricultural research; - the penetration of the internet in developing countries is quantitatively described; - phases in problem-solving agricultural research are identified; - drawing on von Hippel's concept of "information stickiness" impacts of IT on problem-solving research are highlighted and activities which are strongly and weakly affected by IT are pinpointed and - implications of IT for the organization of international agricultural research are suggested and discussed.

XV.6 Concept of the global information architectures in Agricultural Research for Development.

Giovannetti, J.-F.

*GFAR secretariat, Information and Communication Manager,
FAO/SDR, via delle Terme di Crarcalla, 00100 Rome.*

The Global Forum on Agricultural Research (GFAR), since its launching in 1996 aims to be a neutral and transparent stakeholders-led-platform allowing all the stakeholders involved in Agricultural Research for Development (ARD) to a) share information and communicate in amore effective way, b) discuss global and often controversial issues, acknowledging that possible differences do not preclude the enormous potential of co-operation, c) launch and build research partnerships through the design and implementation of Global Programs, d) access to institutional support, in particular for the developing countries NARS. GFAR secretariat, following the recommendations of the Dresden Conference in May 2000 and those of its first external review in November 2001, has also launched a global information program. It aims to support the Regional Agricultural Information Systems (RAIS) for the launching of their information and communication policy, to develop crosscutting activities and synergy between them. GFAR secretariat has developed a specific website (www.egfar.org) so called EGFAR (Electronic Global Forum on Agricultural Research) which aims to a) be the communication platform allowing and stimulating the dialogue between all the ARD stakeholders, b) identify information resources relevant to ARD and enhance access to them through a gateway function, c) build selectively knowledge pools for a few high priority areas identified by the GFAR stakeholders. Some positive results of EGFAR such as the forum of discussions on sustainable financial mechanisms for agricultural research from a NARS point of view, launched by EMBRAPA and the NDIL database will be emphasised. New trends for the development of the website will be also explained. Thinking about the ultimate figure which has to be achieved, this website could just play the role of a portal with a gateway function to the various RAIS, following the principles of subsidiarity and decentralisation.

XV.7 Web Portals 4 Development Research - Example of regional and national information architectures in Agricultural Research for Development

Franzen, H., Parschat, C., Plum, V., Boje, G.

*ZADI, Villichgasse 17, 53177 Bonn and FAO/GFAR Rome,
(Franzen@zadi.de)*

Within the framework of the European Initiative for Agricultural Research for Development (EIARD) and in close collaboration with the European Forum (EFARD), a decentralised, web-based regional information system is being developed, providing road maps to scattered European ARD information sources through a single search interface. EIARD-InfoSys exemplifies how to organise web-based information in specific topical areas like agriculture, fisheries, environment, socio-economics, etc.. The system was initiated 1998 with the support of the EIARD Member States and financial contribution of the European Commission. The system is supplied by a network of National Nodes from all EIARD Member States. The present information system (www.eiard-infosys.org) contains more than 3200 records on relevant ARD-URLs. It facilitates information sharing and supports the transparency of European institutional and human ARD capacities. Further InfoSys provides various communication, news, events and training information facilities. Future developments will increasingly facilitate cross platform data-exchange and management within the framework of the European contributions to research for development.

XV.8 Effects of Education on Adoption of Modern Agricultural Inputs under different Socio-Economic Environments: The Case of Rural Ethiopia

Abay, A.

Centre for Development Research, University of Bonn, Germany

Studies on input adoption and on households' reaction to disequilibria consider education as one of the important factors that positively affect adoption decisions. However, very little is known about the relative contribution of household members' education in the adoption process and about the impact of education on adoption decisions under different socio-economic conditions. This study had attempted to shed light on these two issues using a discrete choice model. The results indicate that the decision making process is a decentralised one in which adult educated members of the household actively participate, casting doubt on the traditional assumption that the household head is the sole decision maker. The result also demonstrate that education and socio-economic environments could be substitutes in modern environments and complementary in traditional ones. This implies that the expansion of education in traditional areas may be economically more attractive than in modern areas since it is usually the only means to break the traditional state of life and the tight grip of custom and traditions in backward areas.

XV.9 Going global: Integrating Alumni Networks in Latin America, South-East Asia and the Arab Region

Deiningner, A.¹, Poppele-Braedt, Chr.²

1 University of Kassel, Department of Agricultural Engineering in the Tropics and Subtropics, Nordbahnhofstrasse 1a, D-37213 Witzenhausen, (deiningner@uni-kassel.de). 2 Centre for Tropical and Subtropical Agriculture and Forestry, University of Göttingen, Am Vogelsang 6, D-37075 Göttingen

Many universities and other educational institutions have lost contact with their alumni once they left their "alma mater". This fact is especially deplorable in the case of students and graduates from LDCs, since these persons were trained as executives and specialists who have to fulfill a special obligation within the development of their home countries. With that in mind, a German consortium of the universities of Göttingen, Kassel and Marburg set up regional alumni-networks in the Arab Region (<http://www.gear-network.de>), in South-East Asia (<http://www.seag-network.de>) and in Latin America (<http://www.recall-alumni.de>). Overall, more than 300 former students in Germany are members of these alumni networks. Amongst the different actions taken within these networks, the arrangement and organization of annual symposia (7 symposia since 1999) in the different member countries are the most important activities. These symposia comprise both a scientific and a networking part. The scientific part gives the alumni the possibility to present their latest research projects and to discuss the results with resource persons from Germany. Within the networking part, concepts and strategies for the establishment and further development of local networks within the member countries are developed and discussed. Beside these symposia, the new means of electronic communication over the Internet play a vital role for the information exchange and knowledge transfer within and also between these networks. For each of the projects, both a website and a discussion list has been set up, the latter can be used both for announcements and for communication or discussion between the members of the network. All three networks will participate in the project Global Campus 21 (<http://www.gc21.de>), that will even improve the opportunities to make use of the new media in the context of alumni networking. Based on our experiences we can state that alumni-networking is a highly rewarding task, bringing mutual benefits both to the alumni and to their former educational institutions.

XV.10 Innovative dairy farmers in the Punjab of Pakistan

Teufel, N., Gall, C.F.

*Institute of Animal Production in the Tropics and Subtropics,
University of Hohenheim (480), 70593 Stuttgart, Germany,
(teufel@uni-hohenheim.de)*

Before the advent of major irrigation schemes, about a century ago, husbandry of dairy animals was the dominant agricultural activity in the semi-arid river-plains of the Punjab. Irrigation enabled the establishment of intensive crop production, providing cash income for a rapidly growing rural population. Dairy production remained subsistence orientated. However, the development of urban and industrial centres over the last decades has led to a substantial market demand for milk and dairy products, stimulating rural milk producers to increase productivity through innovation. A socio-economic study of village milk production in the central Punjab was conducted between 1997 and 1999 with special regard to innovations and future development. Data on resources, practices and objectives were collected in a cross-sectional survey covering 322 households and a 13-month longitudinal survey of 65 households. This presentation focuses on the following three questions: Which are the innovations, smallholder dairy farmers are currently adopting? How can dairy farmers, adopting these innovations, be characterised? Does dairy production differ from crop production regarding the characteristics of successful innovations and their adoption? Results show that innovations aiming mainly at the reduction of animal mortality have already been widely adopted: of 284 smallholder dairy farmers surveyed 89% vaccinate their dairy animals against haemorrhagic septicaemia and foot-and-mouth disease. Innovations improving fertility or labour productivity are currently being adopted: mineral mixture is being fed by 38% of the 124 smallholder households within the area of a dairy co-operative and motorised fodder cutters have been introduced by 14% of all 284 smallholder households. Households having introduced these innovations appear to be endowed with more resources, such as land under own cultivation and adult female buffaloes. Contrary to crop production, improving breed or nutrition has not been attractive so far: AI is used by 5% of small-holder dairy farmers for their buffaloes and the median amount per day of concentrates fed to lactating buffaloes was 2kg both at the time of the survey and five years previously. This suggests either that dairy farmers do not expect available innovations to increase yields significantly or that yield is not the major issue when adopting innovations.

XV.11 Land Improvement and Technology Diffusion in Uganda – A Bioeconomic Multi-Agent Approach

Woelcke, J., Berger, T.

*University of Bonn, Center for Development Research, ZEF-Bonn,
Walter-Flex-Strasse 3, D-53113 Bonn, Germany, (j.woelcke@uni-
bonn.de)*

Land degradation contributing to declining agricultural productivity, poverty and food insecurity is a major concern in Uganda. In addition, population pressure raises the need for a growth of agricultural output. Increased crop output will have to come from higher yields as the arable land frontier is closing. Therefore, it is an important research issue how to assist policy makers in designing policy interventions contributing to a sustainable intensification of agriculture. Incentives for the adoption and diffusion of technologies, which have the potential to reach the objectives of increasing productivity and sustainability simultaneously, have to be identified. A supportive tool to analyse these problems is a bioeconomic model, which combines socio- economic factors like farmers' objectives and constraints with biophysical factors affecting production possibilities. Conventional simulation models, which are based on the method of mathematical programming, largely neglect feedback effects between land management practices and biophysical processes. A bioeconomic model based on a multi-agent approach might help to overcome these weaknesses. Recursive mathematical programming models for each actor represent the individual choice of a farm-household among available land and water use, consumption, investment and marketing alternatives. Inter-household linkages, e.g. informal labor markets and communication concerning technical innovations, can be captured explicitly. Two household surveys were carried out in Mayuge district, in eastern Uganda. The main objective of the first survey was to identify representative household types with the help of Principal Component Analysis and Cluster Analysis. During the second survey households of each type were interviewed in order to gather sufficient information to be able to calculate the technical coefficients needed for the mathematical programming approach. The sampling strategy was developed to fulfil the specific data requirement of a multi-agent approach. With the help of Monte Carlo simulation techniques the survey results can then be extrapolated to the entire sampling universe. Preliminary results reveal the importance of social and personal networks, market orientation and factor endowment for the subsequent bioeconomic modeling work.

XV.12 Promotion of Postgraduate Education in Southern Africa Development Community (SADC) - Experiences and Lessons Learned

Wollny, C.B.A.^{1,2} Molapong, K.¹, Sundstol, F.¹

1 Southern Africa Centre for Agricultural Research and Training (SACCAR), Private Bag 0108, Gaborone, Botswana. 2 Institute of Animal Breeding, Albrecht Thaer Weg 3, 37075 Goettingen, Germany

Since 1988 SACCAR coordinates a regional program on postgraduate training in relevant agricultural subjects at four universities within SADC. The overall goal is to contribute to agricultural development, food security and management of renewable resources in the region. Decision-making and management was decentralised to the individual institutions and a steering committee with the task to develop regional policies, strategies and operations was installed. This committee reports to a regional deans committee, which provides feedback and forwards recommendations to their home institutions. This system initiated a region wide communication process resulting in the start-up of additional regionally offered training programs in the sector. On average the training costs per student are lower than overseas and the program has produced more than 200 MSc and PhD graduates by today. Participatory and demand oriented research requires the integration of student and academic staff into national or regional projects. Of late there has been a shift from on-station to on-farm conducted research. This has facilitated participation of communities in research. Collaboration with the CGIAR system and universities of the region and beyond has been improved through joint training and research projects. Since Internet is available communication has become easier but accessibility and reliability remain an actual problem. The sustainability of a regional training program depends largely on the provision of scholarships attracting highly qualified students. Due to difficult frame conditions it remains a challenge for some universities to motivate national or foreign students to enroll in a regional program. The provision of scholarships, intensive academic supervision and realistic strategic and operational planning and implementations are the key success factors in a regional postgraduate program. In future, use of information and communication technology has the potential to reach new target groups and to support the paradigm change from teacher's oriented to student's centered learning.

XV.13 Farmers' Training and the Adoption of new Upland Agricultural Technologies in the Black River (Song Da) Watershed, Northwest of Vietnam.

Nguyen, T.Q.

*Department of Agricultural Economics and Social Sciences,
Humboldt University Berlin, Luisenstrasse 56, D-10099 Berlin.*

This study aims to understand adoption of maize-related technologies by local farm households in the Northwest region of Vietnam. The study covers both sustainable and yield-enhancing technologies. One of the major objectives is to test the effects of training on adoption rate and farm yield. Previous literature shows that farmers' education and training are important in the adoption of new technologies, particularly with sustainable technologies. Data for the study come from 70 households and were collected by a social forestry development project working in the region. The data were collected as part of the project's impact monitoring activity. As for econometric tools, the probit and ordinary least squared (OLS) methods are employed to analyze the data set. Three models are used: a training model, an adoption model, and a yield model. The findings from the study are interesting. It is shown that farmers with and without training as well as adopters and non-adopters of new technologies are insignificantly different. Training has positive correlation with the adoption of new technologies but shows insignificant effects on yield. Farmers in the study area do not adopt new technologies as a package. Adoption of improved maize unambiguously increases the yield. The adoption of hedge row and fertilizer technologies, however, shows insignificant effects. The findings imply a policy issue of the relationship between training and adoption of new technologies and between yield enhancing and sustainable technologies.

XV.14 Agricultural Technologies for better Quality of the Extension Service in Developing Countries

Havreland, B.

Czech University of Agriculture in Prague, Institute of Trop. and Subtrop. Agriculture. Kamycka Street 3, 160 00 Praha 6 - Suchdol, Czech Republic (havrand@itsz.czu.cz)

The extension work is mostly technologically-oriented and effective with regard to farming improvements. It is not a secret that the professional level of extension staff for advising in the field of sustainable and economical farming technologies, is usually not sufficient enough. But also technological aspects of their advice very often fail in matching professional requirements. Aspects of sustainability and economic effectiveness linked to the technological level in tropical and subtropical agriculture are very often neglected by extension services (workers) and are considered to be not important within lower technological levels. A new methodological approach represented by introduction of technological and managerial programs can be of great assistance to the extension workers. It consists in using a computerized program that could also be used when no computer is available. The Program provides extension workers with more sureness in their technological advice based upon both the availability of updated technological information (particularly on machinery sets and agronomic requirements) and very quick economic (costs) calculations. It is conceived as technical-economic facilitator that should make easier life of "extensionists" at their advisory work. The main outputs will be a reasonable (appropriate) technology for growing crops, and possibility of comparison of different crops on basis of their budgets (crop budgets). The main criterion will be net margin the farmer earns from his crop. The program consists of 5 units that in logical sequence follow one another creating the algorithm of technology building, cost calculations and crop/technology efficiency assessment. "ATMP" MACHINERY/ANIMAL MANAGEMENT UNIT - positioned at the starting point of the whole Program and processes mostly technical and managerial data concerning machinery, animals and labor. "ATMP" TECHNOLOGIC UNIT - conceived to design technologies as sequences of working operations. The "ATMP" ECONOMIC UNIT - analytically reviews the complete picture of costs within individual operations and for the whole technology. "ATMP" CROP BUDGET - final sheet of the calculations containing all the costs and incomes linked to the crop. Finally, "ATMP" COMPARISON TABLE - serves for comparison of effectiveness of different crops grown under comparative production conditions.

Symposium XVI

Human Health and Food Security

XVI.1 New Dimensions in Measuring Economic Costs of Illness: The Case of Rural Ethiopia

Asfaw, A.

*Centre for Development Research, University of Bonn, Walter Flex
Str. 3, D-53113, Bonn Germany*

The conventional costs of illness approach that limits the costs of illness only to financial and time costs is likely to underestimate the costs of illness and the potential welfare gains from different policy interventions in the rural areas of developing countries. In this study, we attempt to investigate the indirect costs of illness on livestock and asset positions of households in rural Ethiopia and more importantly on their income, in addition to the financial and time costs. Attempts are also made to compute the expected treatment and medicine costs of illness, which can be used to approximate the premium level for establishing community based health insurance schemes in the rural areas of Ethiopia. Though we do not find statistically significant association between illness and sale of asset and livestock, we find strong evidence that ill health has a significant negative impact on income of households and the result is robust irrespective of the way illness is measured. The results also show that the indirect economic costs of illness are much higher than the direct economic costs of illness. The results of this study clearly demonstrate that substantial amount of welfare gain can be achieved if some types of rural health insurance schemes can be introduced in the rural areas.

XVI.2 Innovations in risk sharing for voluntary health insurance schemes.

Kaiser, M.

*University of Bielefeld, Faculty of Health Sciences, Section
International Public Health (S-IPH) Universitätsstr. 25, 33615
Bielefeld, Germany, (kaiserfm@yahoo.de).*

Voluntary insurance schemes in less developed countries are a possible solution to reduce the risks of illness among the workers in the informal sector in less developed countries. However, many of these schemes in the informal sector suffer from low coverage and financial instability. The main questions are: How can voluntary health insurance schemes expand the coverage and become more attractive to the target group with the effect of raising risk pooling and how can the financial situation be stabilized? It is hypothesized that by applying an incentive mechanism, namely gambling, the acceptability of voluntary health insurance schemes can be increased. It is suggested to introduce a sweepstakes for the insurance members. Assume that the insurance policy number has the function of a lot. Every individual or household has the opportunity to join the sweepstakes on voluntary basis when they have qualified themselves. Qualifying means: a) the acceptance of additional regulations, e.g. as for instance less coverage of medical care or gate keeper instruments, or b) attendance at preventive health education programs. The value of the lot will increase when the conditions are fulfilled, but can be reduced if the insuree failed the prerequisites. The conditions for receiving a higher lot as well as the prices and the interval of the drawing, the whole design of the sweepstakes, can be adjusted to regional necessities. A sweepstakes combined with a health insurance scheme could have the following advantages: (i) The individual design of the sweepstakes can be an effective instrument for punishing or rewarding personal behavior. (ii) Healthy individuals have an immediate benefit and membership becomes more attractive for uninsured "good risks". (iii) A sweepstakes combined with health education can improve the risk profile. (iv) The sweepstakes' rules can serve as an instrument to regulate the expenditures of the insurance. (v) The "game effect" is an additional incentive for participation. (vi) The awards can improve the household's income. The risk profile, the solidarity, and the financial stability as well as the sustainability could be improved due to the sweepstakes.

XVI.3 Food Security and the Developing Countries in the WTO Negotiations

Daude, S.

University of Hohenheim, Institute of Agricultural Economics and Social Sciences, Dept of Development Theory and Agricultural Policy in the Tropics and Subtropics (490a), 70593 Stuttgart, Germany, (daude@uni-hohenheim.de).

In the Final Act of the Uruguay Round which was concluded in 1994 and from which the World Trade Organization (WTO) emerged, agriculture came for the first time under the rules of the multilateral trading system. In fact, the Agreement on Agriculture (AoA) was one of the most discussed agreements during the round. For developing countries, agriculture is still the most important sector within their economies and the backbone to ensure food security for their growing populations. Given the importance of agriculture, the question arises in which way the AoA affects the food security in developing countries where still over 800 million people are estimated to be food insecure. The agreement stipulates that the continuation of the liberalization process for agricultural products has to continue. The new negotiations started at the beginning of 2000 and are expected to last for several years. From a food security perspective, the AoA seems to be especially relevant and developing countries should put special emphasis on the formulation of their negotiation strategies. The objective of the paper is to describe possible negotiation strategies and to run these scenarios with the help of a global trade model. In a more defensive strategy, developing countries use their negotiation-capital to obtain further special provisions in order to prevent liberalization on their domestic markets. In a more offensive strategy, developing countries agree to open up their markets in exchange for more market access in developed countries. The results of the simulations are analysed and discussed with respect to changes in production quantities, prices, trade and welfare and the resulting effects on food security.

XVI.4 Rural Market Structures and the Impact of Market Access on Agricultural Productivity - A case study in Doi Inthanon of Northern Thailand

Hau, A.M., von Oppen, M.

University of Hohenheim, Germany

It has commonly been recognized that an improvement in the efficiency of transportation is of great benefit to food security and development. A country's agricultural development depends on its investments in transportation, market facilities and services, an improved access to input and product markets for farmers. An improved market access increases agricultural productivity at three levels: first, better market access provides clearer price signals leading farmers to produce crops in which they have a comparative advantage. Secondly, farmers tend to specialize and intensify production within a region, thus producing those products for which the region offers a comparative advantage. Thirdly, market participation will promote the use of inputs and in turn increase agricultural productivity through intensification. The paper is a case study and has the objective to analyze the impact of market access on agricultural production in Doi Inthanon of Northern Thailand. The data were collected in 1997/98 covering the cropping season 1996/97. A comprehensive analysis of the three-stage least square (3 SLS) was used to calculate the data. This comprehensive analysis allows explanatory variables to be seen as additional endogenous variables and allows for simultaneous calculation of equations. The results of the study demonstrate that market access has a positive impact on agricultural productivity directly through specialization and indirectly through intensification. We found that an increase in market access by 1% will lead to productivity increases via resource allocation or specialization effects of 0.94% and via increases of mineral fertilizer or intensification effects of 0.13%. We also feel that this methodology was able to closely capture the complexity of economic relationships within market - induced development. The results of these studies point out to policy makers that investments in roads, transportation routes and other marketing infrastructure improve farmers' physical access to input and product markets and their orientation in production. Studies of this nature strengthen the importance of market access as a determinant for rural development and food security.

XVI.5 Does cattle keeping use family labor of smallholder farmers in Eastern Amazon more productively ?

Bornemann, T., Rischkowsky, B., Siegmund-Schultze, M., King, J.M., Zeller, M.

*Institute of Rural Development, University of Göttingen, Waldweg 26;
37073 Göttingen*

In the Bragantina Region of northern Brazil, traditional slash-and-burn agriculture is facing increasing economic and ecological problems as the human population increases, farm sizes decrease, and fallow periods are reduced. On the face of it, the inclusion of cattle may add to the ecological problems, but they are being adopted by small-scale farmers. There are socio-economic reasons for keeping cattle, of which the most obvious are benefits from milk and/or meat production. Moreover, looking after cattle can be done by older children and elderly people when the able bodied members of the household are working on the crops or off the farm. The hypothesis is therefore that the adoption of cattle is advantageous for smallholders because it allows a more productive use of their family labor. If this were true, then every smallholder should keep cattle, but they do not; so there may be other socio-economic characteristics of the household that influence the adoption of cattle. To test the second hypothesis, the relation between socio-economic characteristics and the presence or absence of cattle will be analysed by logistic regression using data from 67 randomly selected farm-households. The difference in labour productivity will be examined by gross margin analysis of a sub-sample of 16 farms, selected to represent different types of crop and cattle production. The results will be presented at the DTT.

XVI.6 The Role of Upland Rice in Food Security of Farm Households in Northern Vietnam

Pemsl, D.¹, Pandey, S.², Waibel, H.¹

1 Institute of Economics in Horticulture, Department of Economics, University of Hannover, Germany. 2 International Rice Research Institute (IRRI), Los Baños, Philippines

Food shortage and malnutrition are widespread in the mountain areas of Northern Vietnam. The region is characterised by poor infrastructure, sloping land and extreme weather conditions. Farming is subsistence oriented and mainly includes upland crops as only limited access to lowland area exists. Among upland crops especially upland rice is viewed critically by policy makers due to perceived negative environmental impacts and because of the growing rice surplus produced in Vietnam. A joint IRRI - University of Hanover socio-economic study on the role of upland rice for food security in Northern Vietnam was conducted in 1998. To identify constraints and opportunities for farm households in Ha Giang Province a farm level survey among 100 households was carried out. Production function analysis revealed that land scarcity is the most limiting factor for farm income. As found in the survey the production of upland rice is widely practised by many farmers in this region, especially those who experience food shortage. Contrary to the actual situation, economic analysis based on a linear programming model indicated that upland rice is an unprofitable crop due mainly to the high labour requirements for weeding. To establish the "shadow price" of upland rice the economic model was adjusted to minimum monthly caloric requirements of the household following WHO standards. The results showed that land is allocated to upland rice production if a minimum calorie constraint is imposed. Despite its low profitability, upland rice thus contributes significantly to the continuous availability of food for the farm-family over the year and improves food security for farmers. These study results provide important lessons for policy makers who tend to ignore the household level effects in defining food security and when designing strategies to overcome food shortages in rural areas.

Symposium XVII

Post-Harvest Technology - Food Quality

XVII.1 Effects of seed priming with nutrient solutions on germination, seedling growth and weed competitiveness of cereals in Eritrea

Asgedom, H., Becker, M.

*University of Bonn, Karlobert Kreiten Str. 13, 53115 Bonn, Germany
(h_asgedom@hotmail.com)*

In Eritrea, the production of cereal crops is widely limited by poor stand establishment, nutrient deficiencies (P, Zn) and competition from weeds during early crop growth. Subsistence orientation of smallholder farmers limits capital intensive solutions. We hypothesize that combining seed priming (soaking in water and drying back to storage moisture) with concentrating limiting plant nutrients around or within seeds may be an attractive solution to overcome poor stand establishment and P and Zn deficiencies. In addition seed-specific fertilization combined with stimulated seedling vigor may enhance the competitive ability of the cereal crop against weeds in marginal environments. We determined the optimal seed soaking time and the highest possible concentration of P and Zn solutions for high and early germination in petri dishes for important cereal crops of Eritrea (barley, sorghum, millet and rice). In addition, the competitive ability of primed and unprimed seed-grown rice and sorghum with major monocot and dicot weed species (*Euphorbia heterophylla*, *Oryza glaberrima*) was studied and potted soil. In most cereals, water priming stimulated total seed germination rate by 5-10% and increased earliness of germination by 1-2 days. Seed priming effects were most pronounced in rice (52% of seeds germinated 2 days earlier than unprimed seeds) and sorghum (21% higher early germination rate with priming). Optimal priming duration varied from 6 hours in barley and millet, over 24-36 hours in sorghum, to 48 hours in upland and lowland rice. Using these seed soaking times, similar rates and earliness of germination were obtained with additions of Zn at 0.01% (rice) or 0.05% (sorghum) and of P at 0.5% (sorghum) or 1% (rice). Nutrient concentrations higher than those resulted in retarded and lowered cereal seed germination. The effects of seed priming (with and without nutrients) on the competitive ability of upland rice and sorghum against monocot and dicot weed species in a P and Zn deficient soil will be discussed.

XVII.2 Investigation of Post-harvest Soybean Seed Storability after Passing the Different Steps of Processing

Krittigamas, N., Pa-oblek, S., Vearasilp, S., Suriyong, S., Thanapornpoonpong, S., Pawelzik, E.

Department of Agronomy, Faculty of Agriculture, Chiang Mai University, Chiang Mai, 50200 Thailand.

The effects on storability of soybean (*Glycine max* (L) Merrill) seed from different points on the processing line were evaluated between April and October 1999. Soybean foundation seeds from Chiang Mai Field Crops Research Centre grown in farmers' paddy fields were used as seed materials. The experiment was assigned as split-split plot design having 4 replications. The main plot was the sampling sites in the processing line, of which there were 11. The temperature in the storage room was the sub-plot. Two storage conditions were investigated: ambient condition and controlled temperature storage at 15-20 degree Celsius. The sub-sub plot was the storage period. Seed samples were tested monthly for 6 months. The results showed that none of the sampling sites in the processing plant affected the germination and vigour of the seeds after being stored for different periods of time. However, SJ.5 showed better storability trend than Chiang Mai 60. Seeds stored at the controlled temperature (15 - 20 degree Celsius) had higher percentage germination than those stored at the ambient temperature. Percentage of seed germination and seedling vigour decreased with time of storage. This study showed that Chiang Mai 60 has a faster decreasing rate than SJ.5.

XVII.3 Development of Suitable Drying Method for Good Quality Seed of Soybean in Thailand.

Krittigamas, N., Luan-Ti-Song, A., Alikani, Z., Vearasilp, S., Suriyong, S., Thanapornpoonpong, S., Pawelzik, E.

Department of Agronomy, Faculty of Agriculture, Chiang Mai University, Chiang Mai, 50200 Thailand.

The optimum harvesting time of Soybean (*Glycine max* (L.) Merrill.) seed is at the physiological maturity stage but at that time seeds have high moisture contents that reduce their quality. Two methods of pod-drying: artificial drying at 40°C and drying by convection in the shade, were carried out on CM. 60 soybean variety to determine the effect on seed drying characteristic and seed quality at the Department of Agronomy, Faculty of Agriculture, Chiang Mai, Thailand. The results showed that shade drying results in no green and hard seeds. Seed vigor tested by Electrical conductivity showed that artificial drying was less vigorous than shade drying. This was 39.11 vs. 32.89 micro mhos/gram for oven and shade convection methods, respectively. Seed germination on the artificial method was highly reduced than on the shade drying method. However, hot-air drying method reduced seed moisture content to safety moisture levels (9 %MC) in 8 days whereas shade convection drying needed more than 20 days.

XVII.4 New process technologies for lychees and rambutans based on enzymatical peeling procedures

Neidhart, S., Hutasingh, P., Neumann, M., Carle, R.

Hohenheim University, Institute of Food Technology, Plant Foodstuff Technology, 70593 Stuttgart, Germany

Apart from the specialization on selected fruit species, processing of exotic fruits into canned fruits and fruit juices in producer countries is largely undertaken by small- and medium-size enterprises which process many fruit species with different peeling properties throughout the year. Mostly, the fruits are manually peeled, a practice which reduces quality through hygienic problems and biochemical changes resulting from long waiting periods between unit operations. With many exotic fruits, knowledge on the suitability of peeling methods is insufficient. Compared to lye, steam, mechanical peeling, the peeling of exotic fruits with the aid of technical enzyme preparations has, until now, been hardly investigated. Enzymatic peeling procedures were suggested about ten years ago for the production of citrus fruit sections and have been shown to be applicable to some stone fruits such as apricots and peaches. Studying the applicability of enzymatic peeling technologies to selected Sapindaceae fruits, cell wall polysaccharides of three lychee cultivars (*Litchi chinensis* Sonn.) and two rambutan cultivars (*Nephelium lappaceum* L.) have been thoroughly characterized, distinguishing between the edible aril and the peel of these fruits. Composition of the cell wall polysaccharides was shown to be similar among cultivars, but specific for each species of both Sapindaceae fruits. This was found both for the peel and the aril. Enzymatic degradation of the cell wall material isolated from lychee peels and arils, respectively, by commercial peel enzymes and new enzyme combinations was studied using viscosimetry in order to quantify enzyme activities. An optimized enzyme combination and the necessary incubation conditions could be derived from these degradation studies in order to design a laboratory process for enzymatic peeling of lychees. An enzymatic peeling process for lychees (*Litchi chinensis* Sonn. cv. 'Hong Huey') was elaborated in a small pilot plant scale investigating the technological effects of temperature, pH, enzyme concentration and application procedures on peeling time and effect, texture and sensory attributes of the peeled fruits. The applicability of the optimized peeling procedure to other lychee cultivars and rambutan fruits was investigated. Enzymatic peeling procedures were shown to be generally applicable to other lychee cultivars and Sapindaceae fruit species, but any broad use partly requires technological refinements depending on mechanical peel properties specific for individual cultivars or species. Nevertheless, especially for lychees, enzymatic peel degradation enables peeling technologies resulting in fruit qualities highly superior to sensory attributes of fruits from present non-manual peeling processes.

XVII.5 Effect of heat on germination of coat-imposed dormancy. Tetrazolium versus Germination

Ouma, M.K.¹, Janssens, M.J.J.², Schellberg, J.³

University of Bonn, 1 ARTS, Nussallee 1, 53115 Bonn. 2 Institut für Obst- und Gemüsebau, Auf dem Hügel 5, Bonn. 3 Institut für Pflanzenbau, Katzenburgweg 5, Bonn.

Trees are an important component of the natural ecosystem in high as well as low potential areas. *Leucaena leucocephala* (alfafa of the tropics) is considered one of the most widely planted multipurpose trees in the tropics and subtropics. Its seeds in most cases require pre-treatment and are in most cases established in nurseries rendering the otherwise abundant seeds expensive seedlings. Several attempts have been made to establish the best pre-treatment among them heat-treatment. The results have not been very encouraging in terms of increasing the germination rate. No attempt has been made to evaluate the impact of the temperature on seed viability. This study was conducted with the aim of bridging this gap. This study hypothesised that high temperature of short exposure time are able to make otherwise impermeable seeds coats permeable with out compromising viability. Four replicates each of 100 seeds were subjected to 150°C and 250°C for 30 and 60 seconds, then cooled in a dessicator and germinated in pleated paper. Control were non-treated seeds. Normal, abnormal and decaying seeds were counted and removed every second day. At the end of the experiment, the hard seeds were collected and prepared for tetrazolium test. The viable and non-viable seeds were calculated as a percentage of the seeds collected. Germination rate was highest in control 33%, this decreased with heat treatment and duration of exposure with the lowest germination percentage (19%) at 150°C 60 seconds. Germination percentage then increased (27% and 30%) with increased temperature and duration of exposure at 250°C for 30 and 60 seconds respectively. Viability of the seeds decreased with increased temperature and duration of exposure but there was no significant difference among the treatments and seeds viability. It is possible to deduce that the heat treatments were only lethal to seeds with already permeable seeds coats. This is further supported by the fact that 33% germination was achieved in control despite the coat dormancy. Heat treatments were also able to make impermeable seeds permeable. Increases in germination after an initial decrease.

XVII.6 Convenient Seed Production Pattern in Different Populations of *Momordica Charantia* Linn.

Pinmanee, S.¹, Suriyong, S.¹, Vearasilp, S.¹, Thanapornpoonpong, S.¹, Krittigamas, N.¹, Pawelzik, E.²

1 Department of Agronomy, Faculty of Agriculture, Chiang Mai University, Chiang Mai, 50200 Thailand. 2 Institute for Agricultural Chemistry, Georg-August University, Göttingen, 37075 Germany

The convenient seed production pattern in different populations of *Momordica Charantia* Linn. was investigated. The experiment was conducted at Mae-hea Field Research and Agricultural Training Station, Faculty of Agriculture, Chiang Mai University. Two production patterns were investigated by using triangular-support and without support and three populations 10000, 20000 and 40000 plant per hectare were practiced. The results showed that, the best production pattern was without support, which provided best seed quality and better seed germination percentage. The optimum population for produce seed was 10000 plant per hectare, it has show the best number of fruit per plant (20.6) and best 100 seed weight (6.15 gram) The yields of the production seeds from both planting methods are not significantly different.

XVII.7 Optimization the Germination Requirements for *Momordica charantia* Linn.

Pinmanee, S.¹, Suriyong, S.¹, Vearasilp, S.¹, Thanaporn-
poonpong, S.¹, Krittigamas, N.¹, Pawelzik, E.²

1 Department of Agronomy, Faculty of Agriculture, Chiang Mai University, Chiang Mai, 50200 Thailand. 2 Institute for Agricultural Chemistry, Georg-August University, Göttingen, 37075 Germany

The optimization of germination requirements for *Momordica Charantia* Linn. was investigated. It was to find the optimum seed requirements for seed germination at Seed Testing Laboratory, Faculty of Agriculture, Chiang Mai University. There were four sub-experiments. First sub-experiment was to find the best method of breaking dormancy. It was found that soaking the seed in boiling water for 4 second was the best method with 73.5 germination percentage, the removal part of the seed coat by removed half of the seed coat and half of the chlorenchyma membrane, resulted in 75.5 percentage of germination. Second sub-experiment was to find the optimum temperature for seed germination, the results showed that the optimum temperature for seed germination was 30 C with 76 percentage. The seeds could not germinate at the temperature level of 20 C and died up to 42.5 percentage at 40 C. Third sub-experiment was to find the optimum light required for seed germination, the result showed that light was not require for germination. Fourth sub-experiment was to necessary find initial critical seed moisture for germination, the result showed that seed moisture for germination was 36.2 percent and the optimum seed moisture content for best germination was 40 percentage. But they could not germinated when the moisture contents less than 30 percentage.

XVII.8 Affects of Seed-borne *Macrophomina phaseolina* on the Seed Quality in Blackgram.

Rahman, S., Vearasilp, S., Srichuwong, S. Suriyong, S., Thanapornpoonpong, S., Krittigamas, N., Pawelzik, E.

Department of Agronomy, Faculty of Agriculture, Chiang Mai University, Chiang Mai, 50200 Thailand.

Macrophomina phaseolina is a causal organism of charcoal rot disease of blackgram being a seed-borne fungus. To know the actual detrimental effect of this fungus on seed quality of blackgram, an experiment was undertaken by comparing inoculated and non-inoculated seeds. Artificially inoculated seeds of two blackgram varieties with *M. phaseolina* showed three folds lower normal seedlings in comparison to non-inoculated seeds. The main shoot length, root length, and dry weight of seedlings, which implies the seedling vigour, were also found significantly reduced in the both inoculated blackgram varieties. Accelerated aging test (AA-test) showed almost half-normal seedlings in inoculated seeds compared to control treatment that indicates that *M. phaseolina* can decline the storability of blackgram seeds greatly. In AA-test, the proportion of dead and rotten seeds in the inoculated treatments appeared to be doubled than that of control treatment. Nevertheless, no significant change in hard seed in both varieties.

XVII.9 Vacuum Seal and Drying for Better Viability and Storage of Soybean Seed.

Thanapornpoonpong, S., Vearasilp, S., Krittigamas, N., Suriyong, S., Suwannasorn, P., Pawelzik, E.

Department of Agronomy, Faculty of Agriculture, Chiang Mai University, Chiang Mai, 50200 Thailand.

Soybean seed, S.J.4 variety, was processed and dried by closed circuit dryer to 12, 10, 9 and 8 percentage moisture contents. Seeds were bagged in plastic bags, in laminated-nylon plastic bags by vacuum sealing, in plastic bags by heat-sealing and woven-polyethylene plastic bags by machine bagging. They were stored under ambient conditions for 8 months. The results of moisture content of seeds stored in plastic bags and laminated-nylon plastic bags at each initial moisture level remained constant. Seeds in heat-sealed plastic bags slightly changed but were lower than seeds in woven-polyethylene plastic bags, which at each initial moisture level increased and had the highest moisture content throughout the storage period. The germination results of soybean seeds in plastic bags and laminated-nylon plastic bags by vacuum-sealing were 70 % when stored at the moisture content of 8 to 9 % but at a moisture content of 12 %, they decreased in viability rather rapidly to 49.75 germination percentage within 5 months. Seeds in heat-sealed plastic bags, at levels of 8, 9 and 10 percentage moisture, had 70 % germination after 6 months, but when stored at a moisture level of 12 %, germination dropped to 67 % only within 2 months. Seeds stored in woven-polyethylene plastic bags at each initial moisture level dropped in viability most rapidly. Particularly seeds stored at 12 percentage moisture content could not germinate at all after 4 months in storage.

XVII.10 Development of Better Seed Quality of Rice by Pre-drying in Wet Season.

Vearasilp, S., Chaikunta, Y., Krittigamas, N., Suriyong, S., Thanapornpoonpong, S., Pawelzik, E.

Department of Agronomy, Faculty of Agriculture, Chiang Mai University, Chiang Mai, 50200 Thailand.

The effect of pre-drying on reduction in seed desiccation in order to improve quality of the seed yield in early wet season rice was carried out at the paddy fields in San Pa Tong District, Chiang Mai Province, during April-July, 1997. The experiments were designed in a Split-split plot with 4 replications. Main plots were 2 rice varieties (SuphanBuri60 and RD10), while sub plots were four harvested methods: harvesting and storing in the shade during day and night (TR1); harvesting at field maturity (TR2); spraying rice at physiological maturity (PM) with Dimethipin (2,3-dihydro-5, 6-dimethyl-1, 4dithiin1, 1,4,4-tetraoxide) 500 ml/ha (TR3); spraying rice at PM with Dimethipin 750 ml/ha (TR4) and the sub-sub plots were the period during 28-40 days after 50 % flowering. In order to reduce seed moisture content at physiological maturity, which started around 30-33% to 14% (minimum requirement for cereal seed storage), TR4 showed the best results in both the 2 rice varieties (SuphanBuri60 and RD10) and took 4.25 and 4 days, respectively. TR3 tended to be moderate whereas the other treatments required longer periods to reach that level. In terms of seed quality, TR1 also gave the best results. TR1 had markedly higher seed germination percentages and higher seed vigour compared to the other treatments. The average seed germination percentages were 96 % in Suphan Buri60 variety and 98% in RD10. The seed vigor indices were TR1, 26.30 in Suphan Buri60 variety and 29.27 % in RD10. This therefore meant that RD10 was more vigorous than Suphan Buri60. All treatments resulted in no significant differences in yield in both rice varieties. SuphanBuri60 showed better yield (average 5 257.75 kg/ha) than RD10 (3 506.94 kg/ha.) Besides that, TR1 resulted also in significantly less percentage of cracking seeds than the other treatments

XVII.11 Assessment of Post Harvest Soybean Seed Quality Loss.

Vearasilp, S., Pa-oblek, S., Krittigamas, N., Suriyong, S., Thanapornpoonpong, S., Pawelzik, E.

Department of Agronomy, Faculty of Agriculture, Chiang Mai University, Chiang Mai, 50200 Thailand.

The effects on quality of soybean (*Glycine max* (L) Merrill) seeds from mechanical damage during processing were evaluated between December 1998 and April 1999. Soybean foundation seeds from Chiang Mai Field Crops Research Centre grown in farmers' paddy fields were used as seed materials. The experiment was assigned as a split-plot design having 4 replications. Soybean seed variety was assigned as the main plot, and point of sampling in the processing line was assigned as the sub plot. Two varieties, SJ.5 and Chiang Mai 60, were investigated, and 11 processing sites were sampled. The results showed that the soybean seed moisture content after drying in the bin dryer varied with the distance from the central perforated ventilation pipe and the height of bin. The other seed samples were from the central perforated ventilation pipe. The higher they were placed in the bin, the higher was their remaining moisture content. Transportation of the seeds by bucket elevators after being dried at sampling sites 7 and 10 caused a higher percentage of mechanical damage in Chiang Mai 60. Pre-cleaning and air-screen cleaning decreased the inert matter from 0.50 % to 0.13 and 0.03 %, respectively. None of the sampling sites in the processing plant affected the germination and vigour of the seeds. However, SJ.5 showed better vigour than Chiang Mai 60.

XVII.12 Influence of propagation date to sprout development of enset (*Ensete ventricosum* (Welw.) Cheesm.) at different climates

Zippel, K., Lüdders, P.

Humboldt-Universität zu Berlin, Landwirtschaftlich-Gärtnerische Fakultät, Institut für Gartenbauwissenschaften, Albrecht-Thaer-Weg 3, 14195 Berlin (kzippel@gmx.net)

Enset (*Ensete ventricosum*, family. Musaceae) is widely distributed in eastern and southern Africa but cultivated only in southern and southwestern Ethiopia as staple food for about 15 million people in mixed subsistence farming systems. The main product is starch extracted from the underneath corm and the leaf sheaths. Moreover, all parts of the plant are used in household, agriculture and traditional medicine. Propagation is done vegetatively during the warmest and most moist season of the year. Cultivation areas extend from 1700 to 3300 meters altitude with annual average temperatures between 8°C and 22°C and annual precipitation between 900 and 1500 mm. Dry periods lasts from 3 to 8 months. Therefore, different climates in the growing regions enforced the development of different propagation methods. Different propagation methods are described for different climatic regions. These descriptions are compared with data from field trials at 2 sites (Debre Zeit, 1850m and Addis Ababa, 2350m) with different average temperature (18 and 16°C) and rainfall patterns (2805 mm at 97 days and 2576 mm at 170 days). Propagation was conducted in January, April and August under different climatic conditions. Sprouts were examined for their vegetative growth as well as their nutrient and carbohydrate contents after 2, 6 and 10 months. Propagation times differs according to the environment from December to May. Main propagation time lasts from February to March when temperatures with high temperatures and rainfall. However, in regions below 1900m propagation is done in May to provide enough moisture during the long rainy season from June to September while at altitudes above 2400m propagation is done already in December to provide enough heat. In this case special treatment is necessary to provide sufficient moisture. These observations were proven by the vegetative measurements of the field trial while analysis of contents did not show any significant difference.

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Improvement of Traditional Methods of Palm Oil Production in Cameroon

Baumgartner, D.

Universität Hohenheim, Institut für Agrartechnik in den Tropen und Subtropen, 70593 Stuttgart, (daniel-baumgartner@web.de).

Die Palmölproduktion hat in West- und in Zentralafrika eine elementare Bedeutung für die Ernährung und das Einkommen der Landbevölkerung. Seit Generationen wird das wertvolle Öl von Frauen durch mühevollen Handarbeit gewonnen. Bei diesem traditionellen Verarbeitungsprozess werden die Ölfrüchte mit den Füßen gestampft und das Öl aus dem Fruchtfleisch mit Wasser ausgewaschen. Das Ziel dieser Diplomarbeit war die Ausarbeitung eines Projektvorschlags, um die traditionelle Palmölproduktion in Kamerun effizienter zu gestalten und somit einen Beitrag zur Arbeitserleichterung der Landfrauen zu leisten. Als Grundlagen für das Projekt wurden neben der traditionellen zwei weitere Mechanisierungsstufen der Palmölproduktion analysiert und verglichen. Ein Verzeichnis über Pressenhersteller und Maschinenbauer von Kamerun wurde ausgearbeitet und ein Bauplan für eine spezielle Ölpresse für Landfrauen entworfen. Abschließend wurden die Ergebnisse zusammen mit der neugegründeten Frauengruppe "Muetje Numba" diskutiert und gemeinsam eine neue Verarbeitungsmethode ausgearbeitet, die eine Synthese aus Tradition und Fortschritt darstellt. Die neue Methode integriert in den traditionellen Verarbeitungsprozess eine manuelle Spindelpresse. Das Wort "Muetje" stammt aus der Stammessprache Denya, der in Numba/Bamenda lebenden Bevölkerung und bedeutet "Sonnenaufgang". Die Benennung des ausgearbeiteten Projektentwurfs "Muetje Numba" betont die Hoffnung, der dort lebenden Frauen auf Verbesserung dieser anstrengenden Verarbeitungsmethode. Nach Rückkehr und Abschluss der Diplomarbeit ermöglichte ein Missionswerk die Projektfinanzierung und so wurde ein Pilotprojekt im Frühjahr 2001 realisiert. Hierzu wurde in Douala/Kamerun von ausgewählten Maschinenbauern die Ölpresse angefertigt. Anschließend errichtete die Frauengruppe in dem Dorf Numba/Widikum ein Verarbeitungsgebäude in Eigenleistung, in dem seit März 2001 die neue Methode erfolgreich praktiziert wird. Fazit: Durch den Einsatz der Anlage konnte die Arbeitszeit von zehn auf sechs Stunden verringert, die Ausbeute um 50% erhöht und der hygienische Status verbessert werden.

Food Security and the Developing Countries in the WTO Negotiations

Daude, S.

Universität Hohenheim, Institut für Agrar- und Sozialökonomie in den Tropen und Subtropen (490a), 70593 Stuttgart, (daude@uni-hohenheim.de).

In the Final Act of the Uruguay Round which was concluded in 1994 and from which the World Trade Organization (WTO) emerged, agriculture came for the first time under the rules of the multilateral trading system. In fact, the Agreement on Agriculture (AoA) was one of the most discussed agreements during the round. For developing countries, agriculture is still the most important sector within their economies and the backbone to ensure food security for their growing populations. Given the importance of agriculture, the question arises in which way the AoA affects the food security in developing countries where still over 800 million people are estimated to be food insecure. Within a general equilibrium modeling framework two different negotiation strategies of developing countries for the WTO negotiations are simulated. The first simulation is a more "defensive" strategy where developing countries put their negotiation efforts into obtaining further special and differential treatment (SDT) provisions and strengthening the existing ones that were stipulated in the last Uruguay Round Agreement. In the second, more "offensive", strategy developing countries put emphasis on obtaining better market access for their export products and on reducing export subsidies of developed countries. The results show that a stronger liberalization results in increased global production output and shifts in trading patterns. Individual net food-importing developing countries may stay with lower food availability. From a welfare point of view, all countries gain, but developing countries gain most from a correction of their own distorted domestic markets and less from that in other countries. These results lead to the suggestion that the use of SDT for food security should be restrained to fields that individual countries can not influence on their own, e.g. world market price fluctuations, but should be excluded from fields that countries can influence through a change in their domestic policies. Developing countries should be assisted to develop alternative public budget sources and to build up capacities to design and implement allowed support policies in order to enhance production for own food consumption and for exports to obtain foreign exchange earnings.

Sustainable Shrimp - Marktnische oder Wachstumspotential?

Lustenberger, J.

*Wehntalerstr. 41/72, CH-8057 Zürich, Schweiz, Email:
joergl@student.ethz.ch*

Unseren Weltmeeren droht eine Umweltkatastrophe. Die Meere werden zum Teil richtiggehend ausgefischt. Gewisse Fischarten, aber auch Krustentiere wie zum Beispiel Wildkrevetten, sind daher vom Aussterben bedroht. Die Produktion der Krevetten in Aquakulturen ist eine alternative Produktionsart zur Fischerei. Die Krevetten werden in riesigen Becken in Meeresnähe gezüchtet. Nicht weniger als die Überfischung ist auch die Krevettenproduktion aus Aquakulturen in der letzten Zeit ins Kreuzfeuer der Kritik geraten. Der Bau von Aquakulturen hat zum Teil starke Umweltzerstörungen und –belastungen zur Folge. Im Weiteren ist die lokale Bevölkerung nicht selten von ihren Wohnorten vertrieben worden, um den Aquakulturen Platz zu machen. NON-Profit-Organisationen und die Medien berichten immer wieder von solchen Auswirkungen. Diese Arbeit befasst sich unter anderem mit Krevetten aus Aquakulturen, welche anhand nachhaltiger Kriterien produziert werden. Das Ziel der Arbeit besteht darin, mögliche Kriterien für eine nachhaltige Krevettenproduktion zu definieren, welche für ein allfälliges Label in der Krevettenzucht dienen kann. Dabei wird der normative Begriff „Nachhaltigkeit“ anhand verschiedener Kriterien definiert und operationalisiert. Die Kriterien umfassen die Bereiche „Ökologie“, „soziale Gerechtigkeit“, „Ökonomie“, „neue und bestehende Standorte“, „Tierhaltung und –produktion“. Mehrererlöse, welche durch die Schaffung eines Labels erwirtschaftet werden können, müssen möglichst effizient eingesetzt werden. Es geht um die effiziente Allokation des Kapitals. Es ist eine schwierige Aufgabe, eine effiziente Allokation des Kapitals in Hinblick auf die Verbesserung der Nachhaltigkeit gewähren zu können. Ein entsprechendes Label in der Krevettenproduktion erscheint eine gute Möglichkeit zu sein, die Bedürfnisse der Stakeholder (Produzenten, Händler, Importeure, Grossisten, Detailhändler, Gastronome, Konsumenten, sowie Vertreter der Medien und NON-Profit-Organisationen und der Wissenschaft) besser befriedigen zu können. Im Folgenden werden dazu ein paar Beispiele genannt: Mehr Sicherheit; Bewusstseinförderung in der Problematik mit Aquakulturen in Entwicklungsländer; erhöhte Akzeptanz der Produkte; „besseres Gewissen“ bei Krevettenkonsum. Prozesse der Globalisierung sind zum Beispiel: verbesserte Transportbedingungen, beschleunigte internationale Kapitalströme und Telekommunikation. Diese Prozesse machen es heute möglich, dass Produkte, wie zum Beispiel Krevetten über grosse Distanzen relativ günstig transportiert werden können. Unsere Gesellschaft beeinflusst dadurch den Lebenskontext vieler Menschen in Entwicklungsländern und deren Umweltsituation. Es muss alles unternommen werden, damit der Lebenskontext dieser Menschen durch unseren Krevetten-Konsum nicht negativ beeinträchtigt wird.

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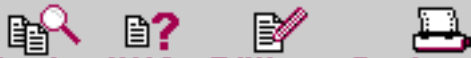
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MS	Menzel-Straße	Heinrich-Heine-Straße		
WA	Wilhelmshöher Allee	Murhardstraße		
DS	Damaschke-Straße	Auestadion		
MULB	Murhardsche Bibliothek	Rathaus		
HOPLA	Holländischer Platz	Holländischer Platz	HoPla	HoPla

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Mönchebergstraße 19
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Rheinische Friedrich-Wilhelms-Universität
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Direktor
Prof. Dr. H. Goldbach

Karlrobert-Kreiten-Straße 13
53115 Bonn

Telefon: + 49 - 2 28 - 73 28
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